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Publicity for Road Maintenance

PRESS items report that the New Jersey State Highway Department has been considering the advisability of discontinuing new construction with State funds for an entire year and concentrating the activities of the department upon the maintenance of existing roads. Whether the report is correct or not it indicates how thorough is the appreciation among road officials of the necessity of proper maintenance, and suggests that such a scheme would give maintenance so great publicity that no one in the State whose influence would be worth while would thereafter be ignorant of its necessity. The merits of the proposal cannot be decided offhand, but certainly the latter result alone makes its serious consideration worth while.

Repeal of Tolls Act

ENGINEERS, in particular, will rejoice that the act repealing the tolls exemption for American coastwise shipping through the Panama Canal has been signed by the President. The waterway will need all it can earn to pay its current expenses and interest on bonds outstanding against it. It was on the basis that all of the shipping will pay tolls that Professor Johnson fixed the rate. Furthermore, the argument that the shippers would be benefited is contrary to all experience, for the steamship companies are sure to charge all that the traffic will bear and to fix their rates by agreement among themselves. Exemption, therefore, was a clear subsidy to vessels already hedged about with ample protection. Jingoes, of course, will continue to howl that we have bent the knee to England, but their wails can safely be disregarded by all sensible men.

Repaving on Sanitary Grounds

ALL advocates of various kinds of paving materials emphasize their sanitary qualities, but it is not often that health promotion is given as the sole reason for repaving. In a recent communication to the Detroit City Council certain worn, paved alleys are described as being in an insanitary condition, on account of the depressions, which hold accumulations of filth and stagnant water, creating a nuisance and menacing the health of the public. The Board of Health having concurred, the Department of Public Works therefore recommended repaving. Mosquito breeders in worn-out pavements are just as efficient in raising the spreaders of malaria as a similar puddle in an unpaved street, with the added advantage to the mosquito that the water is not so likely to drain away, thereby ending the existence of the larvæ by desiccation. While water trapped in clogged eaves, cisterns, ponds, catch basins, sewers and roadside ditches is no doubt the source of most of the urban mosquitoes, numerous inhabited pools have been found by a representative of this journal in the center of traveled unpaved streets. Perhaps, as in Detroit, citizens in other towns can use the persuasive powers of the health officials to advantage in getting worn out pavements replaced.

Piercing Wet-Well Walls

BREAKING into the wet-well of a pumping station during operation is a feat not usually attempted, but there are occasions when it becomes necessary and the day on which it is done is looked forward to with anxiety by the superintendent and afterward referred to with pardonable pride. For this reason, waterworks operators will be especially interested in the article on page 690, describing the leech-like "turtle-back" shield, which the engineers at Chicago devised to enable them to pierce the walls of two large pump pits and make suction-tunnel connections for auxiliary centrifugal steam-turbine pumping units. A cast-iron oval-shaped dished shield was held against the wall by pumping water from the interior, the gasket being made of rubber hose filled with "chemical rubber," a filler for automobile tires. While the elliptical wall at the first station was fitted by the shield with comparative ease, the second well, supposed to be a duplicate, departed just enough from the plans to prevent the gasket from seating. Furthermore, the clearances were so reduced that modern tools in the way of an oxy-acetylene torch had to be commissioned to burn off an I-beam flange during the short time that the pumps could be shut down. The use of rods 36 ft. long for discovering openings, the dynamiting of rock in the tunnel within a few feet of a 40,000,000-gal. pump, and "safety-first" provisions in the way of emergency pumps are other features that warrant more than casual reading.

Studies of Road Economics

THE proposal of the Office of Public Roads to study the road organization and methods of 200 counties has met with enthusiastic approval from those who have sensed the probable benefits. The division of road economics will study all of the factors which affect the economy and efficiency of maintenance and construction. Already the probable benefits can be foreshadowed from some of the studies made. In one State a certain county had been designated by the officials as one of the banner counties. The office approached the study, therefore, in the expectation of finding a model organization. While an unusually low first cost in the construction of macadam roads was found, due to good management and unusually favorable conditions as to material supply, the maintenance organization was far from efficient. The roads of the county were divided into too many sections, which, moreover, were so arranged that each man in the line of his duty frequently traveled over roads in his fellow-supervisors' territory. A county engineer and five supervisors were employed, whereas closer supervision and greater ability could have been secured by concentrating the expenditure on one competent man, giving him such inspectors and subordinates as were necessary to carry out his program. The State highway engineers, in particular, are sensing the value of the investigation. While their own reports to their State Legislatures are apt to be considered prejudiced, and consequently have less weight than they should, the findings of the Office of Public Roads, plainly an impartial body, will be taken at their full worth by those who make the laws and the appropriations. The work deserves the hearty support of all interested in the improvement of highway methods in this country.

Bonus on Construction Work

WHILE much consideration has been given in the industries to bonus systems, their application has made comparatively little progress on out-door construction work. Consequently performances that would be considered ordinary in factories are worthy of note when found on construction work, if for no reason than to encourage others to try the method where conditions are favorable. On an excavation job done by the Aberthaw Construction Company, of Boston, last winter, it was found that 120 loads a day could easily be hauled in wheel scrapers. The teamsters worked leisurely and apparently without interest in the task. The application of a bonus easily within the limits of accomplishment changed the entire tone from half-hearted endeavor to enthusiastic effort. A bonus of 50 cents was given each driver who made 120 loads or more during the day. The bonus was increased to $1.00 for each man who made 150 loads—a mark which several reached. It was expressly stipulated that the horses should not be mistreated in reaching bonus figures and that loads which were not full would not be credited on the tally board. While these instructions were well followed, it is probable that the horses were worked to their limit. As was to be expected the curve of results indicated a reduction in cost as the quantity moved and bonus increased. Whereas the cost at the time the bonus was first applied was 35 cents per yard it came down to 25 cents and under for the peak of the curve, involving a saving of more than $60 a day during the highest output. It goes without saying that bonus cannot be applied on every conceivable job in out-door construction but the untried field for its application is very large. Higher profits await those with skill in devising such systems and executive ability in putting them into effect.

Increase of Bascule Bridge Span Limits

AN important advance in the construction and design of railroad drawspans has been made by connecting two independent bascule leaves into a simple fixed span equal to their combined length. This is effected by simple and ingenious interlocks connecting the top and bottom chords and transforming them into continuous chords of a single span adapted to transmit full tension, compression and shear stresses through the detachable joints in the center panel. The adjustment of the interlock is so easy that no elaborate mechanism is required. It can be effected and the bridge opened or closed in 1¼ min. Protective methods are provided to prevent the possibility of disengagement, except when desired.

A satisfactory engagement between independent bascules has long been a desideratum and has been developed for the structure over the Saulte Ste. Marie canal, described on page 699. It has been in satisfactory operation for over a year. In connecting the chords of the adjacent bascule leaves it was necessary to provide for expansion and contraction of the long trusses due to temperature variations, which, with fixed bearings, would make the chord lock either very elaborate or impossible to operate under varying conditions. This difficulty was met by making one tower and its connected bascule leaf and counterweight movable longitudinally. Simple interlocking devices insure the fixed position of the tower during the operation of the leaves, permit it to be shifted back and forth when the bridge is open, insure it proper closure and allow it automatically to move back and forth to correspond with temperature changes when the bridge is closed.

The improvements have been worked out in a practical manner that opens an important field in drawbridge construction and extends the limit of span lengths to double those heretofore available.

The Liberty-Regulation Cycle

IN the literature of regulation, which is most voluminous, one finds no vistas into a period beyond. Regulation, close supervision of many activities, one would gather, is the ultimate end, the final solution of our governmental and economic problems. Not so, believes Dr. Nicholas Murray Butler, president of Columbia University. In his commencement address on June 3, he viewed regulation as but one element in a cycle of which liberty and its various phases form the other members. A hundred years ago liberty was on the lips of everyone. The American and the French revolution were its strenuous evidences. But things have changed. "That against which the leaders of the race revolted a century and more ago," Dr. Butler said, "is now pressed upon us in another form as a desirable end at which to aim. Not liberty, but regulation and restriction are the watchwords of to-day and they are made so in what is sincerely believed to be a greater public interest." Analyzing the two phases Dr. Butler continued: "Just as the driving force of an engine is to be found in the steam chest and not in the brake, so the driving force in civilization will be found in liberty and not in restriction. The cycle will, in due time and after a colossal waste of energy and of accomplishments, complete itself, and liberty will once more displace regulation and restriction as the dominant idea in the minds of men."

That many will differ with Dr. Butler needs hardly be said. Nevertheless, his views cannot be lightly dismissed by the thoughtful. Those who object to our growing paternalism, who see in Government meddling the prospect of developing a citizenship largely lacking in the stamina which has brought this country to its present division, will take cheer from Dr. Butler's words. It must not be thought from this brief comment that he believes regulation to be without place in government. What he does object to, and what he believes will pass with the completion of the cycle, is the killing of individual initiative by close restriction and regulation. Insofar as the latter instruments protect the liberty of others Dr. Butler believes in their exercise.

An Important Detail in Concrete Road Construction

DIFFICULTIES experienced with two recently built concrete roads point to the necessity for impressing on constuctors the importance of making the plane of all joints vertical. This, at first sight, seems a minor detail. The experiences cited below, however, are convincing to the contrary.

On one of the roads the joint planes were inclined at an angle of as much as 30 deg. with the vertical. When warm weather came, within less than a month of the completion of the job, the expansion caused one slab to move up on its neighbor.

The other case was more interesting and baffled the investigators for some time. There appeared at about eighteen points in a stretch of a mile a chipping away of the upper surface of the concrete, the spalling being in thin slabs about 2 in. thick, extending back sometimes several feet from the joint and across the entire width of the roadway. Strangely, the spalling always took place on the same side of the joint, counting in the direction of travel. Apparently there was but little disturbance of the slab below a plane 2 in. beneath the surface of the road.

It was finally disclosed that the contractor on stopping work each day had finished the wet concrete to a chisel edge on a slope of about 45 deg. On resuming work the following morning this chisel edge was broken off, but in practically all cases not back far enough to secure a vertical joint for the entire thickness of the pavement. The lower part of the joint was vertical, but the upper part was inclined at an angle of 45 deg. The result was just what might have been expected. The expansion of the slabs broke off the 2-in. layer that could not, on account of the 45-deg. inclination, take compression. No expansion joint was placed in this pavement, and consequently the trouble was found only at the points where work had been stopped for the day.

It is not necessary to moralize on this subject. Every road builder will draw the conclusion that his inspectors must insist upon vertical planes at the joints. Only in this way can the concrete take the compression that must be expected on expansion.

Firing Boilers by Surface Combustion

INTEREST has just been awakened in this country in some very striking recent work abroad relating to gas-fired boilers. It has been well established experimentally that altogether remarkable results in localized heating at high efficiency can be obtained by burning mixtures of gas and air on the surface of a body of refractory material. It is possible thus to obtain a very powerful and strongly localized heating action which bids fair to set up an entirely new set of records in thermal efficiency. Recent tests of steam boilers thus equipped are somewhat sensational in their economic results.

The boilers tried out were not large—100 hp or less—and were constructed on the general plan of fire-tube boilers. Instead, however, of being operated in the ordinary way the tubes are substantially filled with refractory material. The gas mixture is fed into the individual tubes under sufficient pressure to prevent blowing back and is burned at the surface of the refractory body. Of course, the whole mass soon becomes intensely hot. The heat is put just where it is needed in relation to the heating surfaces. No elaborate furnace setting is required and the tubes are arranged to be individually controlled so that if desirable a boiler can be kept hot by the utilization of part of the tubes and then thrown very rapidly into action when necessary.

The loss of heat through escaping by-products of combustion appears to be very slight, for the boilers tried have shown an apparent thermal efficiency exceeding 90 per cent, a figure truly prodigious, especially for units of so small size. Gas firing in boilers of ordinary construction has not ordinarily given very high efficiency, while with this special arrangement the results obtained are considerably higher than those reached with even the largest and most effectively handled water-tube boilers.

It is perhaps too early to foresee all the ins and outs of this radically new method of procedure in the use of gaseous fuel. One may safely say, however, that it is extremely promising and ought to be looked into very carefully. If anything like the efficiency thus far recorded can be obtained in regular practice on a large scale there should be a great saving wherever natural gas can be obtained and the possibility of using producer gas, derived from fuel ordinarily undesirable, with results good enough to justify the added complication. All these matters must be threshed out by persistent trial, which, on the face of the returns, would seem to be well justified.

The Alfred Noble Memorial

FROM many sources comes the suggestion that the memory of Alfred Noble be perpetuated by some suitable memorial. Already the matter is under consideration by two of the national engineering societies—the American Society of Civil Engineers and the American Institute of Consulting Engineers—and it is probable that other organizations will co-operate heartily in any plan which may be adopted to honor the man who contributed in such unstinted measure to the uplift of the profession. But before further steps are taken it would be well for those actively interested to reach an agreement as to the most suitable form of memorial. If this is not done at once the various committees having the matter in charge will find themselves working at cross purposes.

As matters now stand the committee of the American Society of Civil Engineers has reported in favor of a bronze statue and suggests that Congress be requested to provide a suitable site for the monument in Washington. The sentiment among the members of the American Institute of Consulting Engineers, on the other hand, is opposed to the idea of a monument. At a meeting in New York on June 11 the trend of opinion was toward some form of memorial, other than a monument, which would be of some benefit to the profession at large.

The Engineering Record believes that the position of the consulting engineers is well taken. Engineers who had the privilege of intimacy with Mr. Noble know his aversion to any form of ostentation. He was a man of rugged simplicity and if it had been possible to consult his wishes it is certain that he would have preferred a memorial which would in some way benefit his fellow engineers.

While no final action was taken by the consulting engineers a number of suggestions were offered. Among them were the establishment of a scholarship at one of the engineering colleges, the use of the interest of a fund to enable a young man to pursue post-graduate studies abroad—and the award of a medal for some signal accomplishment in engineering. These suggestions did not meet with much favor. There are so many medals and scholarships that a more distinctive memorial seemed desirable. Alfred Noble spent much of his time during the latter years of his life in an endeavor to give the profession a broader horizon, and a memorial which would aid in carrying forward his work along these lines, it was felt, would be most appropriate. It was suggested, therefore, that a course of lectures be established with the object of showing engineers how they may play a more important part in civic life. One of the most frequent criticisms of members of the profession has been that they exert little influence in public affairs. If a series of Noble lectures can be effective in stimulating engineers to assume their share of civic responsibility it will accomplish more good than a monument of bronze or marble, and be more appropriate to the character of the man so widely mourned.

Status of Vocational Education

THE latest report of the Commissioner of Education brings to the front the somewhat chaotic present condition of vocational education in the United States. One may include in vocational education many things, but the underlying intent of all is the same, to furnish information of directly practical value to those who leave the public schools early, or who do not find in them the instruction which they individually need. Frankly, there is a good bit of humbug about the term vocational education. The phrase has been and is employed as a species of carryall for various educational aims. Trade schools properly so-called have never been a success in this country on a large scale, the apprentice system is practically dead, and public sentiment is not yet ready to organize suitable schools for the preliminary education of skilled workmen in their respective crafts. There are two chief reasons for this. The employees are jealous of their prerogatives and do not look with especial interest on attempts to train up a great body of young men to take part in competition. Moreover, there is a certain, perhaps unwise, but very definite strain of ambition, which looks askance at special education which seems to lead the boy definitely into handicraft instead of toward the fatter possibilities of business or politics.

The employing class, on the other hand, while fully realizing the serious need of skilled labor, is on the whole, with numerous honorable exceptions, however, not so much desirous to train up skilful and self-respecting workmen from the native born, who will later demand adequate wages, as they are to get imported labor of almost any grade that gives promise of working cheaply, at least for a few years. The degradation of innumerable manufacturing towns throughout the country is due directly to this sentiment among certain large employers of labor. Vocational education, therefore, has a hard path to follow, beset with prejudice on the one side and by half-hearted interest at best on the other. Nevertheless, the more intelligent of the working class, and of the employing class as well, understand that in the long run many boys must be helped to become skilled workmen, for the world's work has to be done and a certain proportion of the world's inhabitants are inevitably destined to do it. The better they are in their vocations the better they are in the long run for all parties concerned. Some of the very best vocational schools are those which have been organized by far-sighted employers of labor, primarily to help their own present and future employees to efficiency.

From the report of the Commissioner of Education it appears that sentiment in favor of vocational schools is increasing. Many communities, through the direct action of the school authorities or the energy of private organizations, are doing efficient work, mostly in the way of evening schools of somewhat technical character, directing the student's energies into well defined industrial lines. This, however, is not enough, for while the more energetic and ambitious, especially those whose home environment leads them to proper ambition, can find in such schools most important help, there is no such general provision for vocational education as can yet reach any large proportion of those whom it is desirable to help.

Hence the work initiated by six States, looking toward direct State aid for general vocational instruction, is of fundamental importance. Speaking broadly, the State acts cover direct vocational schools as an annex, so to speak, to the ordinary public school efforts; continuation schools for part time work, and evening schools for those employed during the day. Each of these has its advantages, which, however, cannot be fully reached until the legislation on the subject is somewhat more than merely permissive. Fourteen, the usual age at which compulsory education ends, has been shown by ample experience to be too early from the standpoint of future citizenship and working efficiency. It is quite true that economic pressure sometimes forces mere children into work, and this must be taken as a present necessity. By far the most effective solution of the difficulty would seem to be the part time continuation school, whereby the child, who on general principles ought not to leave the public school, being forced out from necessity and able to do a material amount toward self-support, can still acquire necessary schooling. The evening schools, generally speaking, reach a slightly more mature group better able to take care of themselves than the children who leave at the minimum school age. The all-day vocational schools might be of great utility in dealing with the situation were there proper legislation to encourage them.

Aside from these public activities is the work being done by the corporations themselves. Upwards of a hundred companies are conducting their own schools at the present time, both because the preliminary training of their employees is unsatisfactory and because, in any event, highly specialized training, which public schools cannot well give, is a profitable investment for the employer.

With all of these agencies waking up to the real seriousness of the problem and educators attacking it from every angle, the next generation should have a good chance to acquire a high degree of industrial efficiency, which in the present state of things cannot readily be reached.

Subaqueous Connections between Tunnels and Pump Wells in Chicago

Construction Carried On in Close Quarters behind Curved Shields Held against the Wet-Well Walls by the Water Pressure

CONNECTING suction tunnels with existing wet wells at two of the Chicago pumping stations was accomplished in 1913 without draining the wells. A cast-iron shield, shaped like a turtle's back, was held against the wall by pumping the water from the interior. The tunnel was then holed through the wall from the exterior into the dry interior of the shield.

The tunnels were constructed to form suctions for new 25,000,000-gal. daily Allis-Chalmers centrifugal pumps driven by Kerr steam turbines, installed in the Springfield Avenue and Central Park Avenue stations between existing Worthington triple-expansion pumps of 40,000,000 and 20,000,000-gal. capacity. The two stations are practically identical in equipment and arrangement. It was necessary to install the centrifugal units in quarters not designed originally to receive them and to do the work without closing down the pumps and thereby affecting the water supply. In each case the work of the city consisted of the construction of foundations, of the sinking and lining of the suction shaft and tunnel to a connection with the wet well which supplies the four existing engines and of placing the steam exhaust and hot-water piping.

TUNNEL AND SHAFT

Underlying the foundations and the pit floor of the Springfield Avenue station is solid rock which required blasting for the shaft and tunnel, a procedure necessitating extreme precaution, as the existing pumping engine foundations on each side were only 20 ft. apart. Drilling, blasting and mucking occupied thirty-eight eight-hour-day shifts, during which 290 1-in. sticks of 60 per cent gelatine dynamite and 568 electrical exploders were used. Blasting was stopped at a point 5 ft. from the interior of the well, leaving 2 ft. of rock and 3 ft. of brick masonry to be removed. About eighty holes, 12 in. deep, were drilled with a 2¾-in. air drill in the face preparatory to the work of removing this last 5 ft., which was to be done after placing the tunnel shield noted later.

The first foot of rock of the 2 ft. remaining when the blasting operations were suspended was mined out later by blasting with the shield in place. Nineteen sticks of dynamite were used in fifteen shots in sixty-two of the eighty holes previously drilled. The rest of the rock, varying from 1 ft. to nothing, and the brickwork, varying from 3 to 4 ft. in thickness, was mined by drilling holes with the air drill and breaking out the material with bull points and sledges. The remaining portion of the tunnel was then lined with concrete of minimum thickness of 4 in., the normal minimum being 6 in. and the average 8 in.

At the Central Park Avenue station the underlying material was hard clay excavated with grub hoes and for the last 2 ft. of the shaft with picks. The circular suction shaft was 3 ft. 10 in. inside diameter with 2 ft. lining. The elliptical eye of the tunnel, 3 ft. 10 in. x 5 ft., was reinforced with an angle-iron ring. A cast-iron curb at the upper end upon which the suction valve and condenser were to be set, was held in place with six anchors extending to the bottom of the shaft. After the shaft and valve pit lining were completed, with the curb and suction valve in place, work was discontinued until the shield could be placed in the well.

Foundations for the pump and pipe piers, though of monolithic concrete, were reinforced as a matter of precaution. The two pipe piers were immediately adjacent to the rough masonry wall of the pit, and to avoid damage to either the wall or the piers, due to the possible settling of the latter, the surface of the old wall, which would be in contact with the new concrete, was plastered on expanded metal lath. These piers were held against the wall with diagonal ties anchored into the wall and placed in sleeves in the pier, permitting the piers to settle without separating from the wall.

PLACING SHIELD IN WELL

In general the shield was rectangular in shape with rounded corners about 8 ft. 7 in. high, 6 ft. 9 in. wide as placed on the wall and 3 ft. through. On the upper end were flanged connections for an 8-in. and an 18-in. pipe. The pattern was made in the city's shops and the casting by the American Brake Shoe & Foundry Company. To make contact with the rough wall the edge of the shield was grooved and fitted with a 2½-in. rubber fire hose acting as a gasket. The hose was filled with "chemical rubber," a filler for automobile tires. The hose was held in the groove of the shield with T-bolts, the heads of which were inserted through the lining.

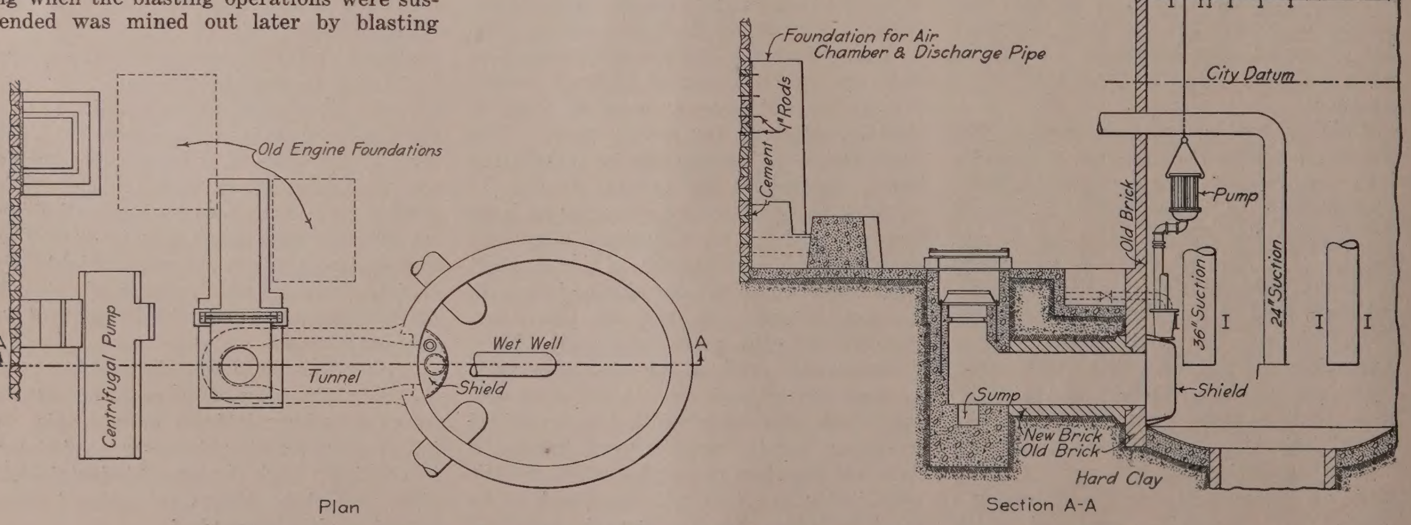
On Aug. 27 the shield was lowered into the Springfield Avenue well with the 24-in. spiral pipe and the two lengths of 8-in. cast-iron pipe attached, using the electric traveling crane of the station. It was supported by two 1½-in. cast-steel locomotive cables, which in turn were suspended from two 3-ton chain falls. These were suspended from 6 x 8-in. timbers supported on the gallery and upper edge of masonry of the well, as close to the masonry wall as the clearances would permit, so that the horizontal component of the diagonal pull of the cables would help hold the shield in place against the masonry.

UNWATERING SHIELD

Efforts to unwater the shield with a No. 4 drive-well jet pump and a No. 3 Blakeslee bilge pump having a combined capacity of 83 gal. per minute lowered the water 0.1 ft. A No. 2 double-cylinder Emerson pump with a 3-in. suction was then secured and produced the desired effect of tightening the shield by lowering the water to the limit of suction in about five minutes. Subsequently the deep-well jet pump took care of the leakage, operating about two minutes out of fifteen at first, and, toward the completion of the work, twenty seconds out of twenty minutes.

For the purpose of providing an emergency safeguard in the event of a possible accident while blasting near the well wall at the tunnel connection, an emergency pump was installed on the pump pit floor ready to operate. A discharge line of 8-in. spiral pipe was provided from the pump pit to an outside sewer.

The hose gasket which had been used on the tunnel shield of the Springfield Avenue station was found to be in bad shape, having been torn across entirely and being badly worn at the four corners of the shield. The hose was spliced with a piece of pure rubber and auto tire sleeves and wrapped with rubber tape wherever necessary. New holes were drilled in the rim of



Plan

Section A-A

Tunnel Construction for Central Park Avenue Pump Installation, Showing Location of Shield

the shield for additional bolts to hold the gasket in place. Considerable difficulty was experienced in lowering the shield into place. Somewhat similar trouble at the Springfield Avenue station had been encountered, but what seemed to be variations from the plans of the construction work below water reduced the necessary clearance space, and the shield could not be lowered below an elevation of—23.

A shutdown on Nov. 1 was decided upon primarily to determine the cause of the trouble and to remove it if possible. It was found that at that elevation the curvature of the shield was flatter than the curvature of the masonry wall. The difference had moved the shield west, or against the 18-in. I-beam supporting other suction pipes. During the time available while the station was shut down an unsuccessful attempt was made with chisels and sledges to cut off enough of this I-beam to permit the shield to pass between the beam and the masonry wall.

During the following week some changes in the shield to fit the actual curvature were made by filling with cement the lower part of the groove in which the hose gasket was held. Filling the groove to a depth of ¾ in. at the center of the top and bottom, and tapering to nothing at the corners, brought the hose away from the lateral support given by the cast-iron groove the maximum permissible amount.

BURNING AN I-BEAM FLANGE

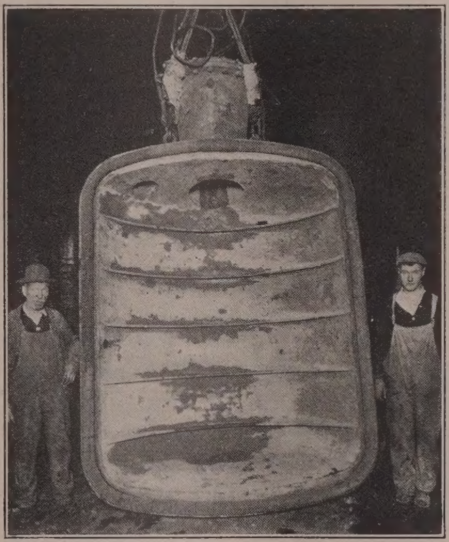
On the night of Nov. 8 a second shutdown took place. An oxyacetylene flame was used to cut off the I-beam flanges up to the web and the shield was lowered past the beam at about 5:30 a. m. On lowering the shield into place under water on the following day the operation of the Emerson pump failed to draw the shield tight and a new No. 4 Nye pump was purchased. Both pumps were operated for two hours with no result. The pumps were then disconnected and removed and the shield raised out of the well the following day. The hose gasket was found to be torn across and pulled out of the groove along the entire upper edge. The hose was worn through at several places and the filling exposed and disintegrated. It was decided to replace the hose gasket with a new one, which was fastened to the shield at twenty-two points with light iron wire. On Dec. 11 the shield was again lowered into the well and the Nye and Emerson pumps were placed and reconnected. Two levers of 3-in. iron pipe with bent iron straps to hook over the old suction pipe I-beam were placed so that they could be used to press the shield against the wall.

Various feeling rods with curved extended ends to fit the shield corner were prepared of ½-in. and ⅜-in. pipe and of 1 x 4-in. lumber weighted down. The pumps were both operated on Dec. 17 and 18, with no apparent effect on the water level in the shield. The only information that could be determined with the feeling rods was that the sides and corners of the shield were tight, but that there might be an opening at least ¼ in. wide along the upper edge. This was found with a 1 x ¼-in. iron beveled at the end and projecting about 18 in. beyond the end of a 1 x 4-in. stick 36 ft. long.

The excessive shaking of the 8-in. pipes projecting from the shield indicated that the whirling motion of the water in the well might prevent the tightening of the shield. On Dec. 19, between 11 and 12 p. m., the pumping engines were shut down, water was permitted to rise in the well and both shield pumps were operated for about half an hour with no result.

CALKING AND GROUTING LEAKS

On Saturday night, Dec. 20, the station was again shut down, and it was found that there was an opening of ½ in. between the gasket and the masonry at the center of the top tapering to a contact near the sides. Eight timber braces were placed between ribs on the back and sides of the shield and the two suction I-beams. The upper opening, about 3½ ft. long, was tightly calked with oakum and a similar opening at the bottom under about 6 ft. of water was plugged from the inside of the shield through the 8-in. hold in the flange on the 18 x 24-in. increaser, using 1 x 4-in. sticks about 12 ft. long as calking tools.



Inside of Turtle-Back Shield

This calking was not satisfactory, but was considered sufficiently tight to hold in place grout which could be placed in the bottom of the shield. Three bags of neat cement and eleven bags of 1:1 sand and cement were emptied into the shield.

On Dec. 26 the Nye and deep-well jet pumps operating simultaneously lowered the water about 15 in. in the shield. The water level fluctuated about 6 in., apparently with the pulsation of the Nye pump. The jet pump was removed and fourteen bags of cement grouting were let into the shield, being poured continuously through a 3-in. pipe placed in the straight 8-in. pipe on the shield. This grouting was permitted to harden for three days and pumping was resumed on Jan. 5.

The action of the discharge from the pumps indicated that the leak was less than the capacity of the Nye pump, but as this pump was suspended just above the normal water level at about —4, the suction limit of the pump prevented the unwatering of the shield. During the final shutdown on Jan. 10 and 11 the pump was lowered so as to operate under water, it being connected to the shield about 15 ft. above the bottom. After this had been done, and during the same shutdown with the water at about —26, the bearing of the shield against the wall was thoroughly calked from the inside with oakum and pine wedges. On the morning of Jan. 11 the water was let into the well. The shield proved to be tight, as evidenced by a special float gage, and the work of breaking into the tunnel was carried out as at the Springfield Avenue station.

The work was done by day labor under the immediate direction of F. C. Martini, assistant engineer, reporting to H. W. Clausen, engineer of waterworks construction in charge of the construction division, a subdivision of the bureau of engineering, of which John Ericson, city engineer, is in charge, assisted by H. S. Baker, assistant city engineer. L. E. McGann is the head of the Department of Public Works of which the bureau of engineering is an integral part.

Valuation of Minneapolis Waterworks for Rate-Making

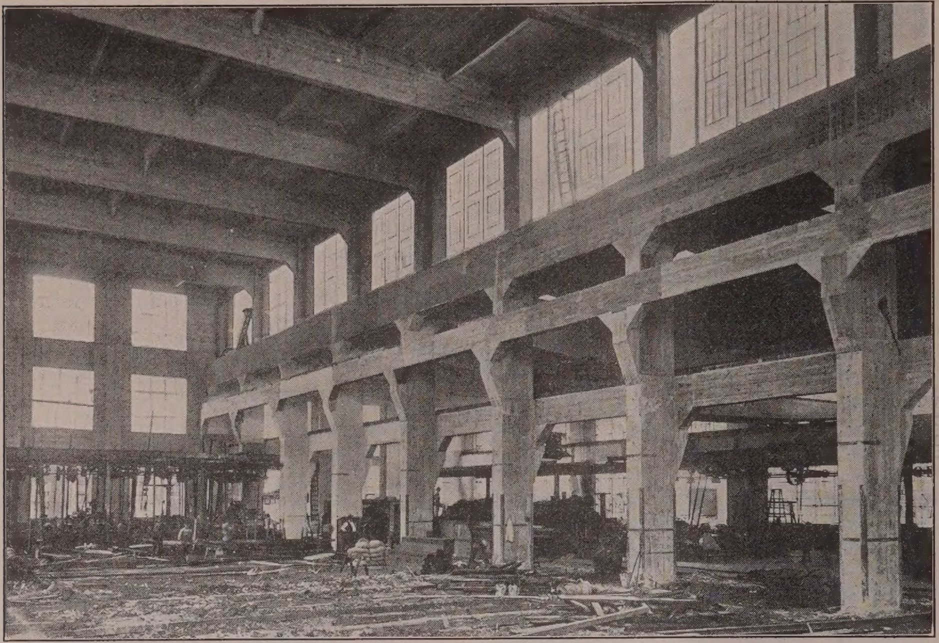
A PHYSICAL valuation of the property of the Minneapolis municipal waterworks for the purpose of establishing a proper charge for the depreciation and interest with the object of putting it on a thorough business basis has been made by F. W. Cappelen, city engineer. Notes from his report submitted under date of May 8 are given below.

The present value paid for by the city is $8,792,174.93 and the book value is $432,761.27 greater. The latter sum has been charged off for depreciation. Of the total about one-third has been raised from bond issues, one-third from assessments and one-third from earnings. So far the city has provided for interest and sinking fund, while the earnings have gone into improvements. All city departments have been furnished with water at one-half rates with the exception of the free water supplied for sewer and street flushing, paving construction, skating ponds, bridge construction, water department and fires, an amount estimated at 965,119,000 gal. for 1913. Total operation and maintenance expense was $273,502.37, or $28.75 per 1,000,000 gal., of which $9.18 was for filtration. The revenue was $481,880.03. Mr. Cappelen figures the free water should be paid for at the regular rate of 8 cents per 1000 gal., adding $83,527.43 to the revenue.

On account of fire protection he calculates $158,579.12 is due, giving a total revenue for the year 1913 of $469,225.80, about $145,700 more than a 6 per cent charge for interest, depreciation and sinking fund on bonds plus the amount paid in assessments by citizens, but nothing on the amount of earnings put back into the plant.

With reference to the fire-protection account the charge is based on the extra value of the works required on account of fire protection, that is to say, the "demand cost." Of the low winter consumption the fire department demand is 45 per cent, of the maximum consumption it is 29 per cent, and of the yearly average it is 40 per cent. The second figure, 29 per cent, was used in making the computations.

WATER CONSUMPTION in San Diego, Cal., during 1913 was 86 gal. per capita and 508 gal. per tap. The city has an estimated population of 80,000 and sells water entirely through meters. The cost of supplying water is $198 per 1,000,000 gal., figured on the total maintenance plus the interest on the value of the plant. On maintenance alone it is 10 cents per 1000 gal. Ten parts per million of aluminum sulphate are applied in the filters where 13 per cent of washwater was used.



Interior of Erecting Shop, Showing Lighting and Double Tier of Crane Runways

Concrete Railroad Shops at Houston

Reinforced-Concrete Buildings with Long Roof Spans for the Galveston, Harrisburg & San Antonio Railway Company

THE new shop buildings at the Houston terminal of the Sunset-Central lines in Texas are entirely of reinforced construction, including roof girders of maximum clear spans up to 63 ft. and runway girders 22 ft. long for 150-ton traveling cranes. The buildings were constructed for the Galveston, Harrisburg & San Antonio Railway Company while work was maintained in the old shops on the same site, and reduction of the cost of the construction was considered in adopting uniform design and dimensions.

MAIN FEATURES

The buildings are one-story high, with flat-slab roof, hipped skylights and reinforced-concrete walls and spandrels supported by the columns. The walls have large window areas fitted with steel sash and frames grouted into grooves in the concrete. The roof and runway girders are concreted integral with the columns and kneebraced to them, thus giving longitudinal and transverse rigidity. The heaviest runway girders are seated on the tops of the columns and the lighter ones are supported on brackets introduced to diminish the column sections. The effects of bending stresses in the columns due to eccentric loads thus imposed were investigated and found not to be serious for any possible conditions of loading.

The reinforced walls have ½-in. horizontal rods about 12 in. apart in both faces and light vertical rods as required. The buildings were made without expansion joints and have endured extremes of high and low temperature without developing cracks.

All lighting wires are run in metal conduits embedded in the concrete work. Provision for bolting pipes and other fixtures to the building after completion, in positions which could not be anticipated by the motive power department, was made by anchoring into the walls at intervals plate shapes flush with the surface of the concrete and having a thickness sufficient to permit tap bolting.

In order to prevent unequal settlement from crane loads maintained a long time in one position, the column footings were proportioned to reduce the soil pressure so much that settlement would not occur under maximum dead loads, and live loads were disregarded.

TIME ELEMENT

After preliminary and general plans and all computations had been completed, arrangements were made for commencing the work as quickly as possible; and as it was found that materials for the foundations could be secured immediately, construction was commenced within two weeks, and ample time was afforded for detailing the superstructure while the foundation and preliminary work was in progress. Sand, gravel and cement could be quickly delivered, thus avoiding a delay of six months, which it was estimated would have been required for designing and fabricating structural-steel buildings. The durability of the reinforced-concrete construction, the low maintenance charges, and its resistance to locomotive fumes made it more desirable than steel, in the company's estimation.

One of the greatest difficulties encountered was the necessity of erecting the new buildings on the same site as the old shops, containing machinery in operation and hundreds of workmen, without interfering with them unnecessarily or interrupting their operations. The sites of a number of the new columns were occupied by machines. The shafting was temporarily supported, the vertical supports for slabs and girder forms were braced to form towers, and upper supporting members were trussed. Fortunately the roof was much higher than the old buildings, so that the old roof was left practically intact as a protection against weather and a shield for falling material, and holes were cut through it to receive the vertical supports and column forms.

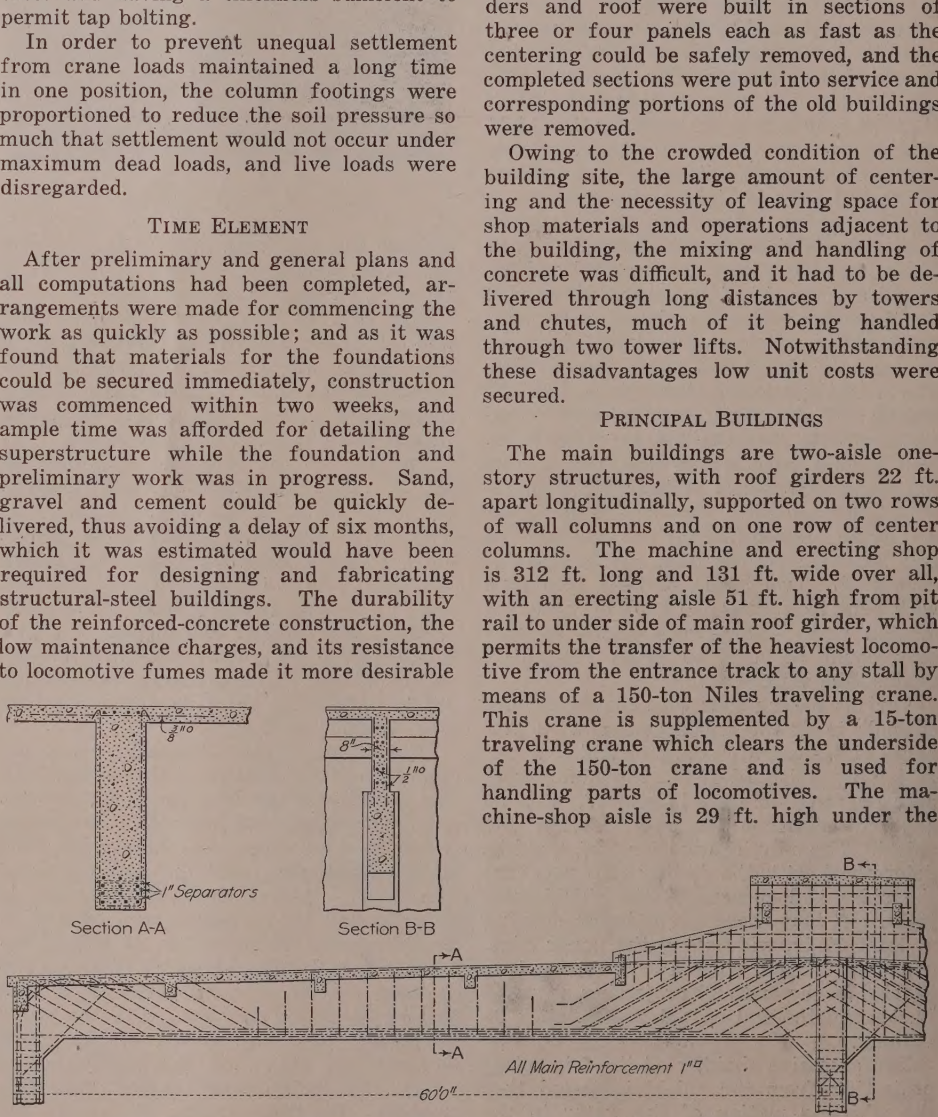
STANDARD SIZES

In order to economize forms the panel lengths of all buildings were made uniform and as far as possible the members in different buildings were made of the same or similar dimensions to permit the repeated use of the forms, some of which were used as many as six times. They were treated with crude oil, and were tripped without difficulty. Instead of completing all of the footings, columns, walls, girders and slabs in single successive operation, the footings, which were generally large, were usually built at night and on Sundays as opportunity afforded, and the columns, walls, girders and roof were built in sections of three or four panels each as fast as the centering could be safely removed, and the completed sections were put into service and corresponding portions of the old buildings were removed.

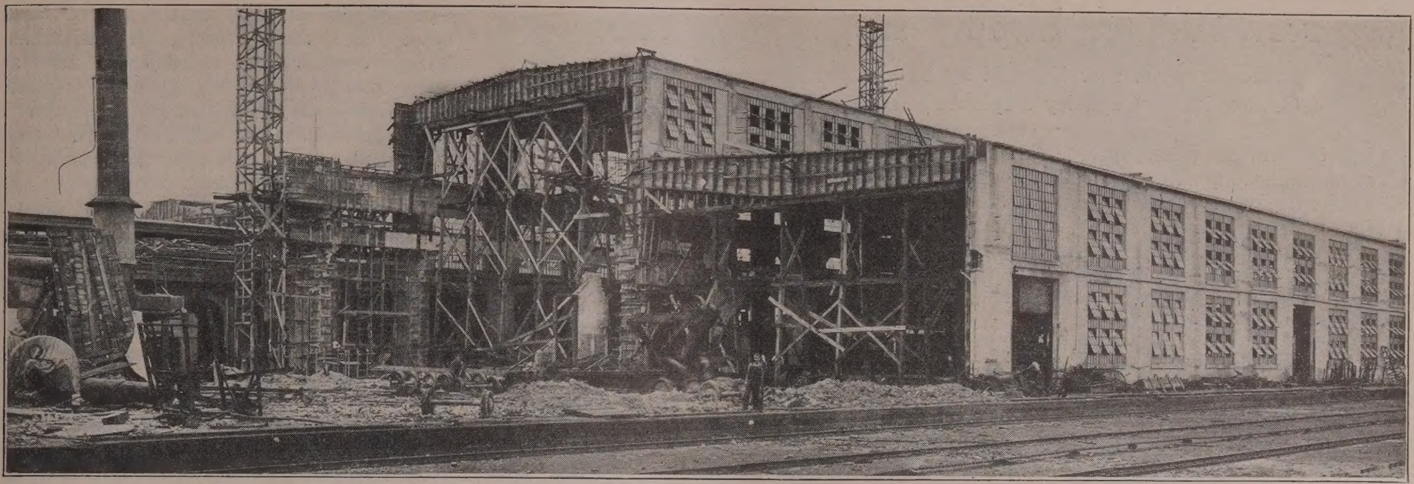
Owing to the crowded condition of the building site, the large amount of centering and the necessity of leaving space for shop materials and operations adjacent to the building, the mixing and handling of concrete was difficult, and it had to be delivered through long distances by towers and chutes, much of it being handled through two tower lifts. Notwithstanding these disadvantages low unit costs were secured.

PRINCIPAL BUILDINGS

The main buildings are two-aisle one-story structures, with roof girders 22 ft. apart longitudinally, supported on two rows of wall columns and on one row of center columns. The machine and erecting shop is 312 ft. long and 131 ft. wide over all, with an erecting aisle 51 ft. high from pit rail to under side of main roof girder, which permits the transfer of the heaviest locomotive from the entrance track to any stall by means of a 150-ton Niles traveling crane. This crane is supplemented by a 15-ton traveling crane which clears the underside of the 150-ton crane and is used for handling parts of locomotives. The machine-shop aisle is 29 ft. high under the



Half Elevation of Two-Span Continuous Roof Girder in Boiler Shop



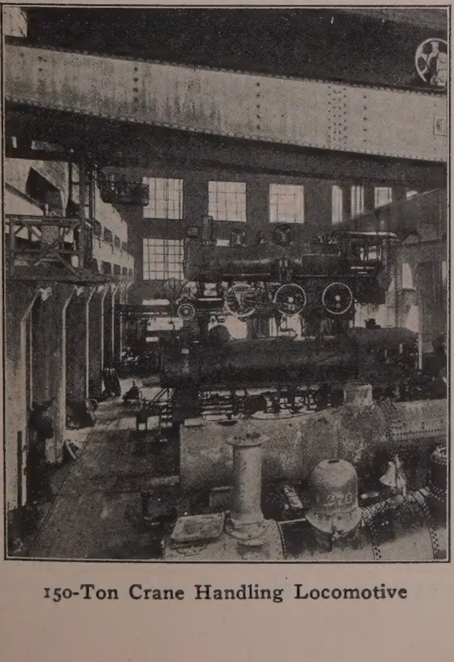
Construction of Erection and Machine Shops in Sections before Removal of Old Shops on Same Site

roof girders and is served by a 15-ton traveling crane. The outer wall of the erecting shop has fourteen rolling steel doors 12 ft. wide and 20 ft. high, above which there are two tiers of windows. The outer longitudinal wall of the machine shop has four large rolling steel doors with large windows between them and windows above them. The ends of the building have three tiers of windows, and the roof is lighted by 6 x 10-ft. hipped skylights.

The 120 x 314-ft. boiler shop is symmetrical about the center longitudinal line and is served by a 15-ton traveling crane in one aisle and a 50-ton crane in the other aisle. It is connected with the machine and erecting top by transverse tracks running from the bays in one building to the opposite bays in the other building. One end of the building is made permanent and the other end has a wooden framework covered with galvanized iron and easily removable to permit future extension. There are three tiers of windows in the sides and ends and skylights on each side of the ventilating monitor on the longitudinal center line. The two 60-ft. spans of roof girders are continuous over their center supports and carry thin reinforced-concrete walls at the middle points to support skylights and ventilator.

The 84 x 90-ft. power house is of sectional construction, with a temporary end wall providing for the addition of future units as may be required. The boiler room is designed for boilers fired with crude-oil fuel, and therefore has no coal bins or ash pits. The reinforced-concrete stack, 6½ ft. in diameter and 125 ft. high, has a capacity of 1400 hp. Detail drawings of all steam, water and air piping were prepared, and the pipes and fittings were delivered and fitted for erection. The machinery was set and the cutting was done so accurately that it was necessary to cut only one length of straight pipe in assembling the entire equipment.

The 25 x 22½-ft. oil house has a basement the full size of the building, with five 8000, two 1000 and two 480-gal. tanks, besides one 8000 and two 2000-gal. tanks buried outside for storing gasoline and distillate. All tanks are connected to self-registering pumps.



150-Ton Crane Handling Locomotive

Increasing Height of Concrete Dam Curved on 72-Foot Radius

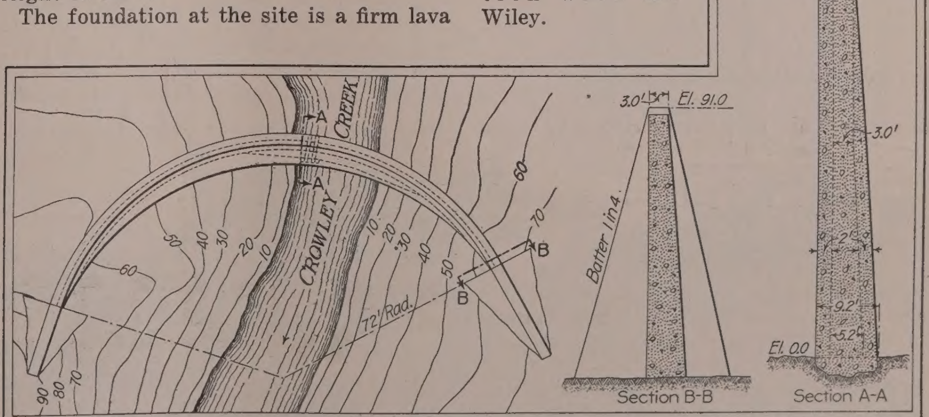
Structure 90 Feet High to Have No Reinforcing, Depending Wholly on Arch Action

SINCE 1907 the Malheur Livestock & Land Company, of Boise, Idaho, has supplied irrigation and domestic needs from a reservoir on Crowley Creek maintained by a dam 55 ft. high and built on a curve of 72-ft. radius. This structure has been found very satisfactory, as it has had more than a foot of water flowing over it on several occasions, it is reported, without developing any sign of failure or weakness. Recently it has become desirable to increase the reservoir capacity and plans were prepared and a State permit was granted for the raising of the original structure to a height of 90 ft.

The foundation at the site is a firm lava rock, and this was first laid bare along the curved center line of the dam, and a trench 1 to 2 ft. in depth was cut to secure a firm bond. No reinforcing was used in the original dam, and none is to be put in the present extension, entire dependence being placed on the stability of the arch, which will include a central angle of 133 deg. inside the wing walls of the 90-ft. structure. The length on the crest is 223 ft., and at the level of normal low water in the creek the length is 40 ft. The crest of the dam at its central point is 1 ft. lower than at the wing walls, toward which the crest slopes gently upward, so that the overflow tends to concentrate at the center, but in flood seasons the entire length between wing walls becomes a spillway.

The dimensions of the slender section of the structure are given in the accompanying drawing, in which the dotted outline within the section *AA* represents the outline of the original dam. An outlet for regulating the reservoir level is provided by a pair of 12-in. pipes through the base of the dam. They are fitted with gate valves in the downstream ends. When filled to the 90-ft. level the reservoir will cover 66 acres to an average depth of about 36.4 ft., affording a storage of 2400 acre-ft.

The original structure was designed by A. J. Wiley, of Boise, Idaho, and plans for the extension were made by A. T. Ingalls, also of Boise, in consultation with Mr. Wiley.



Plan and Sections of Curved Dam in Idaho

New Water Supply for Waco, Texas

Brazos River Water Filtered by Mechanical Plant of 5,000,000 Gallons Daily Capacity Replaces an Outgrown Artesian Supply

BRAZOS RIVER water, filtered through a mechanical plant of 5,000,000 gal. daily capacity, has recently been substituted at Waco, Tex., for an inadequate, diminishing artesian supply. The main pumping station of the old system, which obtained its water from 120 driven wells and a few large open wells, was located on the east side of the river in a dangerous place, being subject to damage from floods. The principal part of the town was on the opposite side of the river and was reached by two 12-in. cast-iron pipes laid under the river, where they were in danger of being broken during floods from shifting sands and caving banks.

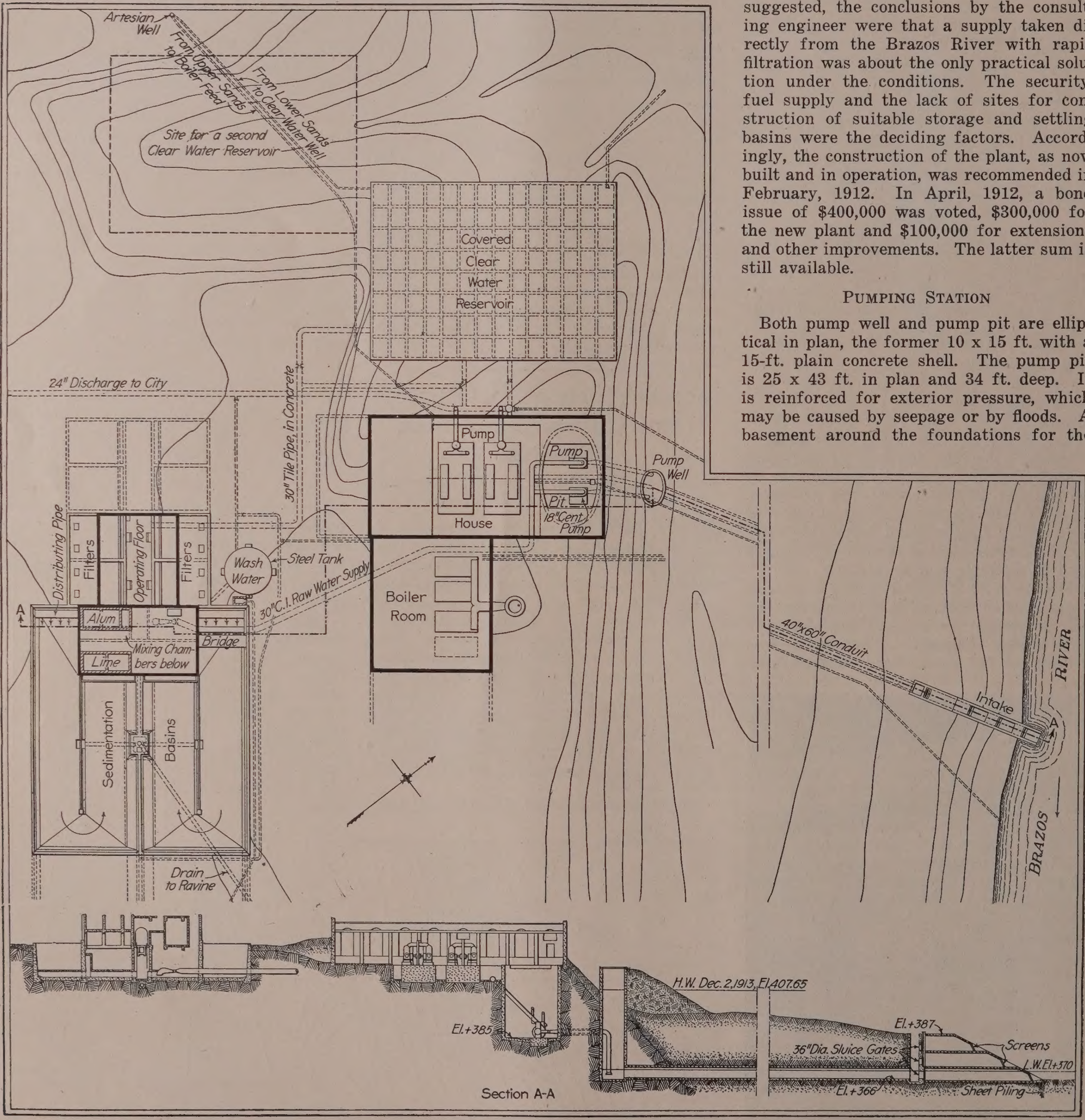
The new plant is located on the west side of the river and comprises a three-inlet intake connected to an elliptical wet well by an egg-shaped, reinforced-concrete conduit 5 ft. high, low and high service pump houses in the same building with a boiler plant, two round-the-end baffled sedimentation basins of three hours' storage capacity, four 1,250,000-gal. daily filters, a 1,000,000-gal. clear-water basin covered with a slab and girder roof and a 423,000-gal. standpipe.

From 1872 to 1889 a private company supplied the city with water from open wells sunk into a water-bearing stratum underlying part of the city. In 1889 some artesian wells had been sunk and a new water company was formed to supply the city with water from these wells, which at that time furnished a very good flow under pressure. The water table was gradually lowered and in a few years it became necessary to use compressed air to produce the required supply. By 1900 the cost of pumping with compressed air began to exceed practical limits and both supplies had become insufficient. After heavy financial losses the two companies were consolidated in 1899, and in 1900 an additional supply was secured from driven wells on the east side of the river. Then the city purchased the entire waterworks.

After a general study of the situation and of a number of different plans previously suggested, the conclusions by the consulting engineer were that a supply taken directly from the Brazos River with rapid filtration was about the only practical solution under the conditions. The security, fuel supply and the lack of sites for construction of suitable storage and settling basins were the deciding factors. Accordingly, the construction of the plant, as now built and in operation, was recommended in February, 1912. In April, 1912, a bond issue of $400,000 was voted, $300,000 for the new plant and $100,000 for extensions and other improvements. The latter sum is still available.

PUMPING STATION

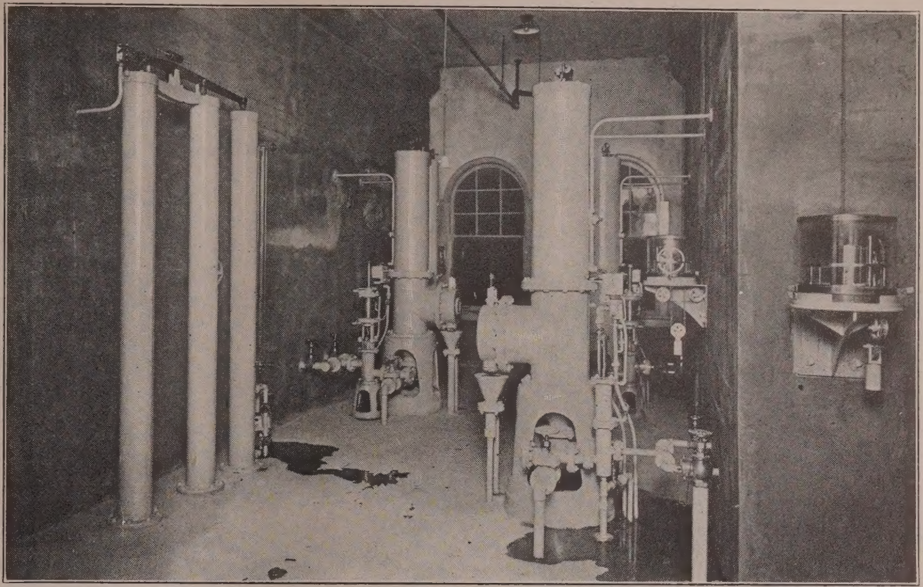
Both pump well and pump pit are elliptical in plan, the former 10 x 15 ft. with a 15-ft. plain concrete shell. The pump pit is 25 x 43 ft. in plan and 34 ft. deep. It is reinforced for exterior pressure, which may be caused by seepage or by floods. A basement around the foundations for the



Plan and Cross-Section of the New Water Supply System and Mechanical Filters at Waco, Texas high-service pumps was provided to make the machinery easily accessible.

In the low-service pump pit are two 6,000,000-gal. daily centrifugal pumps. The maximum lift is 56 ft. and the duty is more than 50,000,000 ft.-lb. A chronometer controlling valve on the steam supply prevents any overflow of the sedimentation basins.

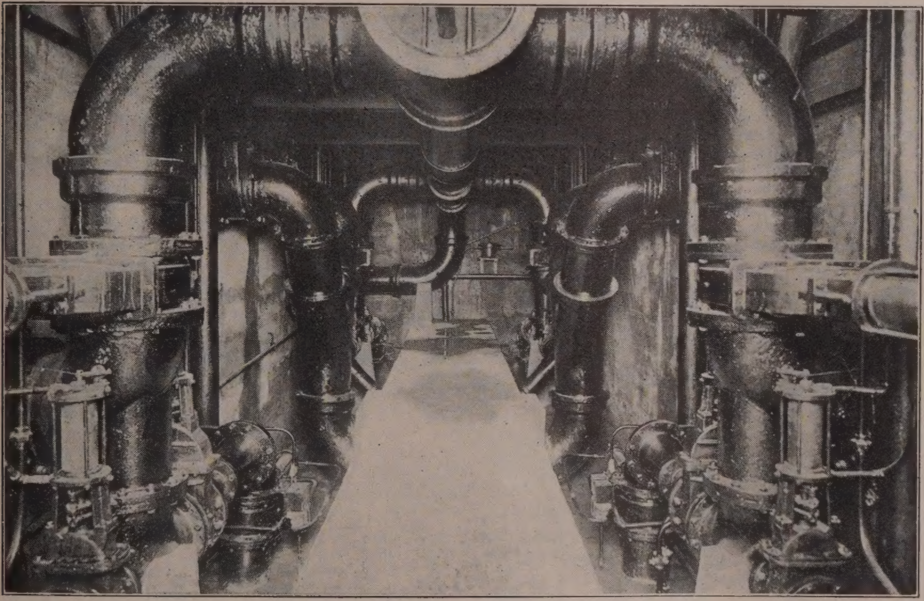
The high-service plant consists of two Allis-Chalmers horizontal cross-compound condensing pumping engines, each having a capacity of from 5,000,000 to 7,000,000 gal. in twenty-four hours against an average head of 207 ft.; the duty is 143,000,000 ft.-lb.


Apparatus for Controlling Application of Chemicals Automatically

BAFFLES FOUND UNDESIRABLE

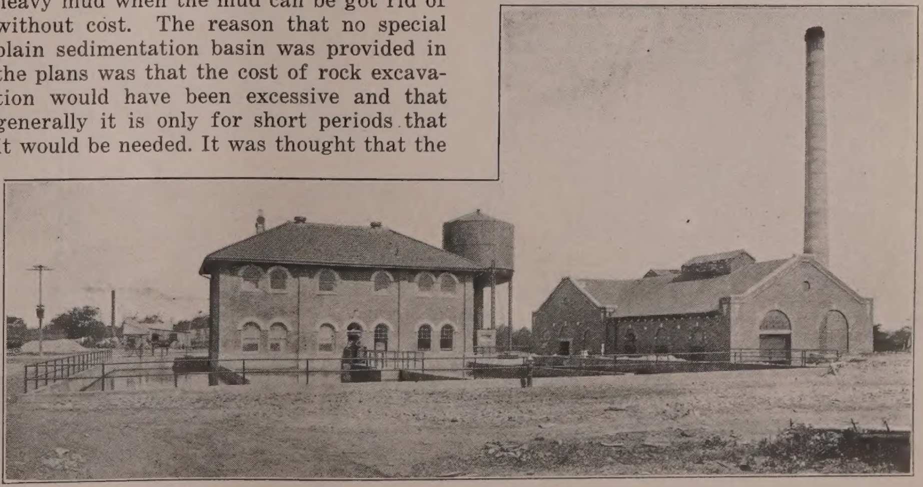
In the filter plant layout, shown in the drawing, the lower part of the headhouse was intended to serve as a mixing chamber, 30 x 54 ft. in plan and 15 ft. in depth. It was divided by walls so as to form a passage 15 ft. wide, in which was placed a number of vertical baffle boards. There was also a little gate chamber at the head of the distributing pipes to the sedimentation basins. The water was to be treated as it entered the mixing chamber. This arrangement worked well with water of low turbidity, but it was soon found that the water needed only little mixing, that the reactions took place very quickly, and that for waters of high turbidity containing very heavy particles these were deposited to too large an extent in the mixing chamber. The highest turbidity was reported to be 22,000 parts per million. The representative of the filter company then removed nearly all of the baffles, changed the point of application of iron and lime to a point where the water entered the distributing pipes and placed a baffle in front of the distributing pipes to diffuse the water entering the sedimentation basins. The results then became satisfactory, according to the engineer. Practically, the mixing chamber was converted into a small settling basin, allowing nearly an hour for plain sedimentation, thus relieving the raw water from the heaviest sediment before the application of the chemicals.

Arrangements were then provided so that the raw water, when exceptionally turbid, could first be carried through the eastern basin for natural subsidence, then treated and passed through the western basin and to the filters. There can be no doubt, the engineer states, of the need of a little plain sedimentation for water carrying such heavy sediment in suspension and of the error of burying expensive chemicals in heavy mud when the mud can be got rid of without cost. The reason that no special plain sedimentation basin was provided in the plans was that the cost of rock excavation would have been excessive and that generally it is only for short periods that it would be needed. It was thought that the occasional use of additional chemicals would be about as economical as the added interest charge.


Arrangement of Pipe Gallery at Waco Filter Plant

On the headhouse floor, level with the operating floor of the filters, are the chemical-solution tanks, filled from an upper floor; the proportional feed chemical controllers of the Earl type, recording gages showing consumption of chemical solutions, a blower for air wash, and a well-equipped laboratory. A stairway and an Otis hydraulic elevator for handling chemicals connect this floor with the upper storage floor. The pipe gallery is of the type developed by the filter company. Concrete flumes are used for the treated as well as for the filtered water. The valves are hydraulically operated from operating tables, on which are samplers which at all times show the effluent. On the operating floor are also placed the effluent rate controllers of the Earl type and recording gages showing consumption of wash water, losses of head and level of water in the clear-water reservoir.

Wash water is taken from the high-pressure mains and stored in a 50,000-gal. elevated tank with the top 41 ft. above the operating floor. The tank is provided with a Golden-Anderson altitude valve to prevent overflowing. With the high efficiency of the high-service pumps it was deemed more economical and much simpler to have this arrangement than a wash-water pump.


Filter Building and Pumping Station of Waco Waterworks

The difference in cost of pumping with the low-service and with the high-service plant, as well as the necessity of keeping down the low-service lift, decided the floor levels of the plant. Several thousand dollars could have been saved in rock excavation, but only at the cost of operating expenses and the prospects of trouble with the low-service pumps.

The standpipe, 60 ft. in diameter and 20 ft. in height, is located in the highest part of the city, where a block of land was donated to the city. The elevation of the top is at 617, while the business portion of the city is at about El. 420. Some time in the future it is intended to construct a 10,000,000-gal. reinforced-concrete reservoir on the block on which the standpipe is now located.

Part of the excavation and the pipe laying was done by the city's forces. The Pittsburgh Filter Manufacturing Company had the general contract for the filter plant, subletting the concrete work to the Reach & Manigan Paving Company, of Fort Worth. The Chicago Bridge & Iron Works built the standpipe and the wash-water tower. J. S. Harrison & Sons, of Waco, erected the pumping-station superstructure, for which Milton W. Scott & Company were architects.

N. Werenskiold, of Dallas, made the original investigations and remained as consulting engineer throughout the construction for the Waco Board of Water Commissioners, the members of which serve without pay. S. J. Quay is superintendent to the board.

THE RELATIVE DESTRUCTIVENESS of the teredo and the limnoria are briefly discussed by F. B. Ridgway, of the International Creosoting & Construction Company, of Galveston, in his report to the company on the creosoted piling in the Galveston Bay bridge of the Santa Fé. Mr. Ridgway does not dispute the common opinion that in waters where both the teredo and the limnoria work the action of the latter is the more severe and difficult to retard. He points out, however, that after a stick of timber has been honeycombed by the teredo and the wood structure almost completely torn down it takes but little effort on the part of the limnoria to finish the job and get credit for the whole thing. He states that he has noted a number of instances where this appeared to be the case and where close examination revealed the fact that the teredo had progressed farther than the limnoria.

Operating Results of Staten Island Refuse Destructors

Comparative Data for Municipal Plants at West New Brighton and Clifton—One a 60-Ton and the Other a 90-Ton Installation

FIVE years' experience in the disposal of the refuse of the Borough of Richmond, New York City, is summarized in a forthcoming report on operation and costs by John T. Fetherston, formerly engineer-superintendent and now commissioner of the New York Department of Street Cleaning, and Thomas M. Kelly, acting superintendent, Borough of Richmond. The borough is served by two mixed-refuse-incinerating plants—one a 60-ton Heenan plant, erected at West New Brighton in 1907 and 1908 and described in the Engineering Record of Oct. 3, 1908, page 386, and the other a 90-ton plant of the same type erected at Clifton in 1913.

New Brighton Destructor

The furnace of the New Brighton destructor contains four grates in series, is hand-fired at the back and hand-clinkered in front. Hot clinker is dropped into cooling chambers on the lower floor, whence it is removed in wheelbarrows or buckets to be crushed or sent to the dump adjoining the building. The operating costs for 1909, 1910, 1911 and 1912 are given in Table 1.

Detailed costs for 1911 are given in Table 2. In the operation and maintenance figure of $1.30 per ton in Table 2, as against $1.27 in Table 1, it will be noted that there is a charge of $250 for water.

Experience with the West New Brighton destructor demonstrated, according to the report, that the plant was operated for five years without complaints of nuisance in a locality where odors would certainly result in serious legal complications; that by-products (steam and clinker) were obtained, the sale of which would decrease the cost of disposal if existing laws did not prevent their advantageous utilization, the value of the excess steam alone being esti-

Table 1—Cost of Operation, West New Brighton Destructor

	1909	1910	1911	1912
Number of tons incinerated	9375	8827	9244	8960
Cost per ton	$1.23	$1.34	$1.27	$1.37
Supervision	2,763.50	2,920.06	2,544.38	2,714.83
Labor	8,044.31	8,210.06	8,488.99	8,389.24
Supplies	348.93	291.30	354.05	809.62
Materials for repairs and replacements by department labor	195.32	166.62	240.86	*....
Repairs and replacements by contract or open market order	72.55	112.90	70.25	176.74
Apparatus, machinery, etc.	40.16	....	....	....
Proportion of automobile maintenance, horse maintenance, etc.	....	29.79	27.08	47.71
Fuel	75.55	80.67	47.95	85.77
Contingencies	2.00	46.98	8.33	19.28
Totals	$11,542.32	$11,858.08	$11,781.89	$12,243.19

* In 1912 Supplies and Materials combined.

Table 2—Detailed Total Costs, West New Brighton Destructor, 1911

General Data

Plant erected 1908; capacity, 60 tons per 24 hours of mixed refuse.

Amount burned 1911, 9244 tons.

Average temperature combustion chamber, 1750 deg. Fahr. (Fery pyrometer).

Average CO_2, 8.8 per cent (CO_2 recorder).

Evaporation per pound refuse (from and at 212 deg. Fahr.) 1.23 lb. (water meter).

Average percentage clinker, 40 per cent (estimated).

Ashes, 68 per cent Garbage, 24.9 per cent Rubbish, 7.1 per cent	Average composition of materials burned.

Investment

	Cost	Estimated life, years
Land	$5,070.25	
Building, chimney and runway	37,233.85	50
Furnace, boiler, fan engine, etc.	23,995.00	15
Retaining wall	2,266.62	50
Platform scale	230.00	15
Sidewalk, approaches, etc.	903.00	30
Steam piping, heating	263.95	10
Engine, generator, machinery (approximate)	5,000.00	20
Engineer's house	9,416.50	50
Total	$84,380.17	

Annual Expense—Fixed Charges

Interest at 4½ per cent	$3,797.11
Depreciation, on annuity basis (4½ per cent interest)	1,633.01
Total	$5,430.12

(Funds assumed to be reinvested in city bonds.)

Operation and Maintenance

1. Supervision	$2,544.38
2. Labor	8,488.99
3. General Supplies	354.05
4. Repairs and replacements by departmental labor	240.86
5. Repairs and replacements by open order	70.25
6. Proportion of automobile maintenance, horse maintenance, etc.	27.08
7. Fuel	47.95
8. Contingencies	8.33
9. Water, etc. (estimated)	250.00
Total	$12,031.89

Credit Account

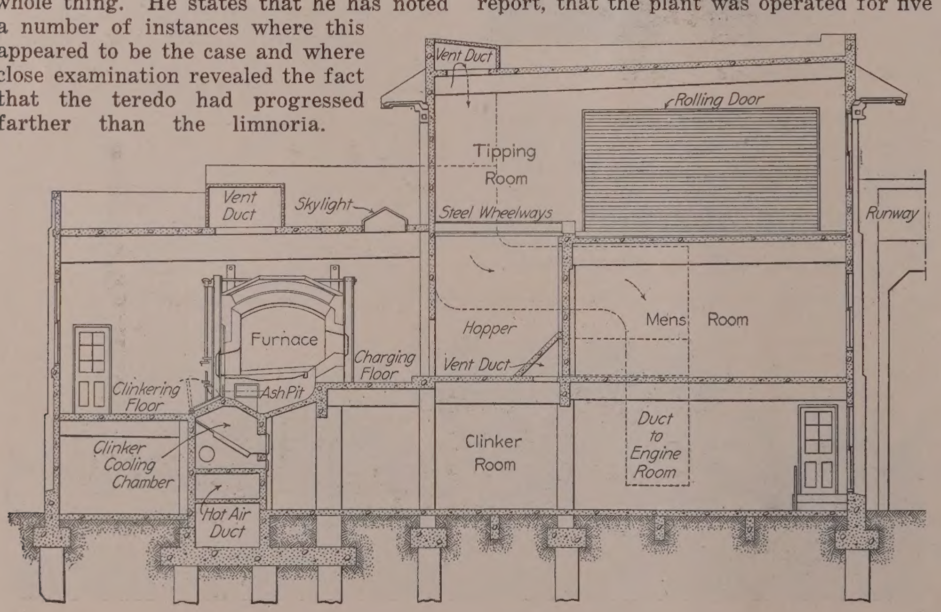
Crushed clinker used by Bureaus of Sewers and Street Cleaning, 870 tons at $1.00	$870.00
Crude clinker for fill, 2871 tons at $0.75	2,153.25
Power furnished brick-testing laboratory (estimated)	50.00
Total	$3,073.25

Recapitulation 1911 *Account*

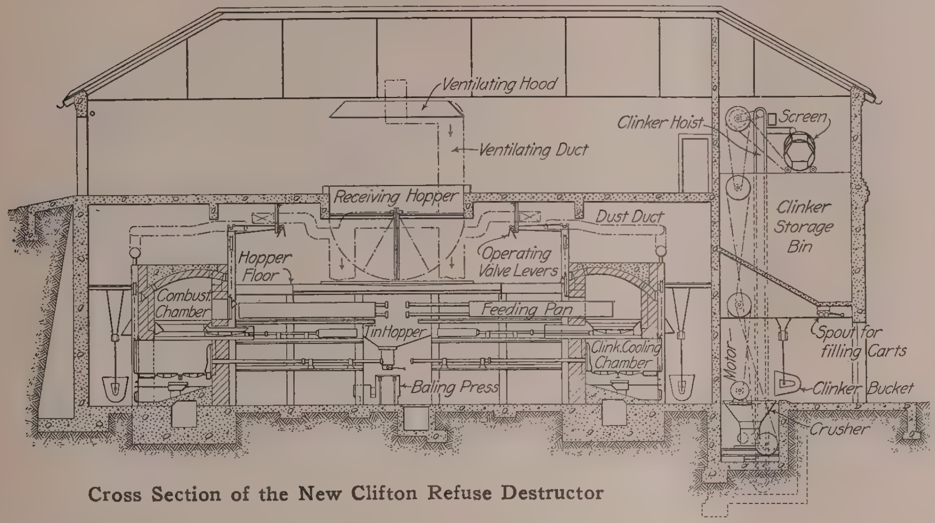
		Per Ton
Operation and maintenance	$12,031.89	$1.30
Fixed charges	5,430.12	.59
Total expense	$17,462.01	$1.89
Credit account	3,073.25	.33
Net cost		$1.56

Regular Force Employed

1 Engineer at $4.50 per day (part time on other work).
1 assistant engineer at $3.50 per day.
8 furnacemen at $900 per annum.
1 extra furnaceman at $900 per annum (acts as watchman).



Cross Section of the West New Brighton Refuse Destructor



Cross Section of the New Clifton Refuse Destructor

mated at $4500 per annum; that the work of the furnacemen was very arduous and should be reduced in future installations which the city might undertake.

A cross-section of the West New Brighton destructor is shown on page 696.

CLIFTON DESTRUCTOR

In 1911 contracts were awarded to the Destructor Company of New York City for the construction of a 90-ton Heenan destructor, serving a population of 39,462. As a result of experience at the West New Brighton plant and tests on a small experimental furnace erected to try out mechanical means of charging and clinkering the Clifton destructor was provided with full labor-saving devices.

The Clifton installation consists of two 45-ton furnace units with two 150-hp boilers, one 50-kw electric generator, hydraulic pump, accumulator, clinger crusher and appurtenances complete. Opposite each furnace door is a pan with a movable back or pusher, which is forced into the furnace by a hydraulic ram so as to completely cover the grate. On the reverse movement of the pan the pusher is held stationary and shoves the refuse on to the grate in the same relative position it occupied in the pan. A cross section of the Clifton plant is shown on this page.

Clinkering is accomplished by a flat grate provided with two ridge bars and attached to a hydraulic ram, so arranged that the movement of the grate breaks up the clinker and allows it to drop into the cooling chamber below, whence it is removed by another ram attached to a pusher which shoves the clinker into a bucket. Clinker in the bucket is cooled by water and then crushed in a roller type crusher, elevated, screened and placed in hoppers for removal by carts. The furnace was subjected to four tests during the summer of 1913, with the results shown in Table 3.

A comparison of work elements obtained during tests of the West New Brighton and Clifton plants are given in Table 4.

CONCLUSIONS

As a result of the Clifton destructor tests and the normal operations of the plant, the reduction in the arduous labor of charging and clinkering has been accomplished. The operating cost at Clifton has been decidedly reduced, though some time must elapse before the complete economy of the mechanical devices is demonstrated.

Each plant has proved beyond a doubt that the type of high-temperature mixed-refuse destructor, efficiently operated, and dealing with material collected in the districts concerned, creates no nuisance from unconsumed gases. The remaining local problem is to utilize the by-products—steam and clinker—to the best advantage.

Besides disposing of the waste in a sanitary manner, mixed refuse has been collected during 1912 in the Borough of Richmond for 10 cents less per capita per annum than separately collected refuse in 1904. This represents a saving of approximately $7500 per annum in the two districts of West New Brighton and Clifton, which should be credited to the destructors.

After ten years' study and experience, considering all other methods of disposal applicable to the Borough of Richmond, it is believed that high-temperature mixed-refuse disposal is best adapted to the local conditions in that borough. Investigations of other means of disposal for different cities likewise tend to the belief that each municipality must work out its own salvation in this regard.

TABLE 3—WORK ELEMENTS OBTAINED DURING OFFICIAL TESTS AT THE CLIFTON DESTRUCTOR FOR ONE 45-TON FURNACE

Work Elements	Summer mixture, North Furnace, Jul. 24, 1913	Winter mixture, North Furnace, Jul. 29, 1913	Summer mixture, South Furnace, Aug. 13, 1913	Winter mixture, South Furnace, Aug. 15, 1913	Totals
Duration of test (hr.)	7	8	7½	8	30 hr., 34 min.
Weight of material (lb.)	46,350	51,367	51,450	54,420	203,587
Cost of incineration	$9.69	$10.69½	$10.41½	$10.87½	$41.67½
Cost per ton	$0.418	$0.417	$0.405	$0.400	$0.4094
Lb. burned per hour	6621	6421	6800	6802	6660
Lb. burned, sq. ft. of grate per hr.	143.3	139.0	147.2	147.2	144.2
Weight of clinker (lb.)	12,615	20,995	13,680	23,125	70,415
Per cent clinker to raw material	27.2	40⅞	26½	42½	34.6
Number of pan charges	61	50	66	59	236
Av. weight per charge, lb.	760	1027	780	922	863
Av. time to load pan (2 men part time)	4 min. 56 sec.	4 min. 59 sec.	4 min. 11 sec.	3 min. 34 sec.	4 min. 23 sec.
Av. time, one man to load	7 min. 28 sec.	9 min. 58 sec.	5 min. 28 sec.	5 min. 30 sec.	6 min. 56 sec.
Av. time per charge to grate	27.5 sec.	20.6 sec.	23.0 sec.	23.1 sec.	23.7 sec.
Total time charging to grate	27 min. 59 sec.	17 min. 10 sec.	25 min. 17 sec.	22 min. 40 sec.	1 h. 33 min. 6 sec.
Per cent time furnace doors open	6.6	3.6	5.7	4.8	5.1
Number of fires clinkered	15¼	16 2/3	18	21	70 11/12
Average clinker per fire, lb.	827.2	1259.7	760.0	1101.2	992.9
Average time to clinker	58.7 sec.	3 min. 9 sec.	57.3 sec.	59.7 sec.	1 min. 31.2 sec.
Time of removing clinker from cooling chambers per fire	1 min. 38 sec.	1 min. 25 sec.	1 min. 21 sec.	1 min. 25 sec.	1 min. 27 sec.
Time to cool clinker with water per fire	4 min. 3 sec.	22 min. 39 sec.	8 min. 19 sec.	17 min. 48 sec.	13 min. 44 sec.
Time to crush clinker per fire	9 min. 30 sec.	11 min. 51 sec.	5 min. 51 sec.	10 min. 8 sec.	9 min. 19 sec.

TABLE 4—COMPARISON OF WORK ELEMENTS—OFFICIAL TESTS

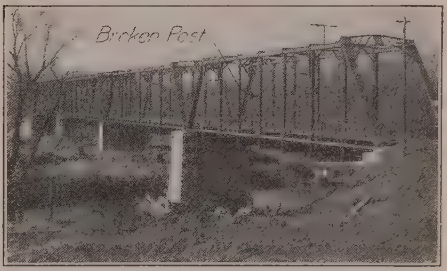
Plant	Cost per ton supervision and labor	Pounds burned per furnaceman per hour	Pounds burned per square foot of grate per hour	Percentage of time furnace doors open
West New Brighton—1908	$0.76	1357	54.3	*73.7
Clifton —1913	.41	3330	144.2	5.1

*Obtained after official tests.

Replacing a Broken Bridge Panel Post under Traffic

Ice in River Removes Falsework Five Minutes after the Last Pin Had Been Driven

DERAILMENT of an interurban car on bridge A-117.8 of the Illinois Traction Company over the Sangamon River at Riverton, Ill., broke in half one panel post in the third panel of the 116 ft. 10-in. pin-connected iron span, badly bent two main diagonals and broke three counter diagonals. While this accident occurred some time ago, it recalls the recent disaster at Attica, Ind., described in the Engineering Record of April 11, page 223 of the Current News section. The eight 14 ft. 7¼-in. panels are 22 ft. center to center of pins vertically and the trusses have a clearance between them of 16 ft. The top chord and end posts are made up of channels and cover plates, with lattice work below. The panel posts are two channels latticed together, while the lower chord and all diagonals are eyebars.



Bridge with Broken Post Indicated

To make immediate temporary repairs, two sets of blocking were set across the bottom chord bars and on this blocking were erected 8 x 8-in. timber shores each side of the broken post; these were wedged to take the sag out of the top chord. This expedient enabled the bridge to carry the traffic for about ten days while the new post was being made. In the interval falsework was placed under the damaged truss.

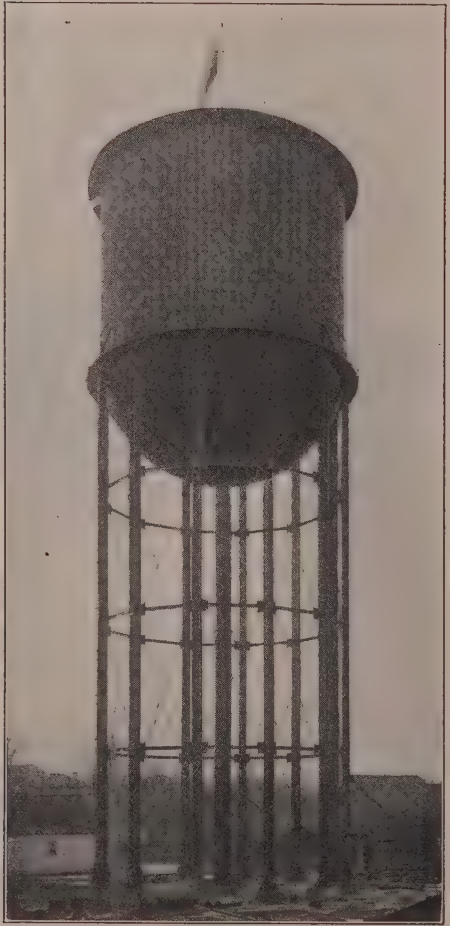
Removing and replacing the pins was a

difficult proceeding, as they were rusted and coated with dry, hardened paint. Replacing the lower-chord pin was particularly arduous, as high water continually scoured the river bed around the base of the falsework, which consisted of 6 x 16-in. shoes or sills bolted to the 12 x 12-in. posts set in the river bed as nearly as possible under each panel point. The posts were braced and capped in line with the damaged truss, a set of wedges being placed under each floorbeam. With these edges the truss was raised several times to a true camber line before it was possible to insert the pin. The time between the passage of cars was only from ten to thirty minutes, and every car settled the falsework enough to throw the bridge out of the camber line. Finally, by jacking and wedging the truss above a true camber the pin was inserted.

While the pin in the lower chord was out two pull jacks with chains were connected to the pins in the first panel on each side of the damaged post. Ratchet jacks were used to force the end posts in.

To obviate the difficulty of removing pins on either side of the broken post for replacement of the broken diagonals, a U, or yoke, was hooked over the pins and connected to the old counter at the turnbuckle. The main diagonals were straightened with a clamp and ratchet jack at the bend. To reinforce the bent main diagonals temporarily to carry the traffic after the new post was in and the falsework had been swept away, two pull jacks with chains were attached to the top chord in the second panel and to the pin in the lower chord of the third panel.

During the latter part of the repair period floods came and ice piled up against the falsework. Just a few minutes after the last pin was driven one post of the falsework gave way, so weakening the remainder that in a short time it had all been carried downstream a short distance to a railroad bridge. From this point most of the timber was recovered from the ice.



Canada's Largest Elevated Tank

The work was carried on by G. A. Wright, division foreman of bridges and buildings, under the general supervision of L. B. Martin, engineer maintenance of way for the Illinois Traction Company.

Canada's Largest Tank

Water Tower at St. Thomas Is 131 Feet High and Holds 600,000 Gallons

THE largest elevated steel water tower in the Dominion of Canada has been completed recently at St. Thomas, Ontario, for the improved city water supply. The capacity of the tank is 600,000 U. S. gal.; height to top of tank, 131 ft. 2¾ in.; diameter, 46 ft., and height of shell, 37 ft. 3¾ in.

This elevated tank is high enough to give an average pressure of about 48 lb. per square inch in the mains at the tower site, with a possible minimum pressure of 35 lb. and maximum of 56 lb. per square inch. The inlet and outlet is of standard weight 14-in. cast-iron pipe and the pipe is protected from freezing by a wooden frost jacket having four thicknesses of lumber and building felt. The tank is kept full at all times by the use of a Golden-Anderson controlling altitude valve on the 14-in. inlet line. This valve may be opened at any time from the pumping station by means of an electrical attachment.

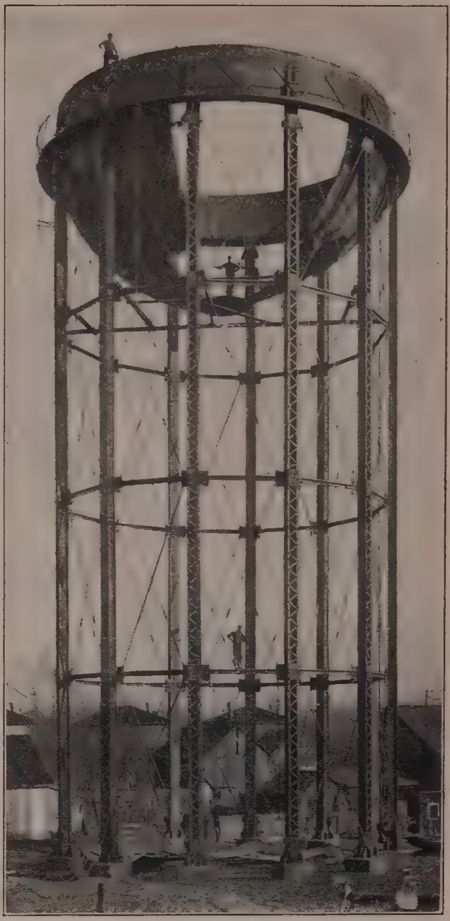
The twelve posts making up the tower are of built-up section consisting of two 15-in. channels weighing 50 lb. per foot, with one cover plate, which varies in thickness from 13/16 in. at the bottom to 7/16 in. at the top. The columns are laced on the other side, which makes a section which may be readily painted at any time.

The horizontal members in the tower are made of two 6-in. channels weighing 8 lb. per foot, and the rod bracing between columns varies from 1¾-in. rods at the top to 2-in. rods in the bottom panel. A heavy system of rod bracing is provided at each strut level to keep the vertical tower rigid under wind pressure. Clamps are provided about the wooden frost casing which take the stresses from these rods and in no way distort the frost case.

The tank itself is made of ½-in. plate in the lower part of the cylinder and diminished to ¼-in. plate at the top. The bottom of the tank is made with double lap-riveted joints, the metal being ⅜ in. thick at the connection to the cylinder and 7/16 in. thick at the extreme bottom.

SPECIAL CURVE FOR BOTTOM

The bottom of this tank is made to a special curvature, which is used exclusively by the firm manufacturing this structure. The bottom in section is a three-centered curve which connects to the vertical cylinder on a tangent to this curve. In this design there is no other stress transmitted to the cylinder than in the commonly used hemispherical design. The advantage claimed for this bottom is that it is more shallow than a full hemisphere. the total depth being 18 ft. 2 in., while the hemisphere would be nearly 5 ft. deeper. This particular curve is selected because it gives the greatest capacity for the amount of steel used and reduces the stresses in the bottom to a minimum. Furthermore, it gives sufficient slope to the bottom so that no sediment will remain in the tank.



Construction of Curved Bottom

Each of the columns supporting this tank is anchored by means of two 1¼-in. anchor bolts to a massive block of concrete. The footings measure 5 ft. square at the top and extend down to a depth of 4 ft. 9 in., where they are 11 ft. 6 in. wide by 13 ft. 6 in. long. Each foundation is surmounted with a block of rich concrete.

The complete water tower exclusive of foundations was built for about $27,000. The engineer for this improvement was M. Ferguson, city engineer of St. Thomas. The design was submitted by the Pittsburgh-Des Moines Steel Company, of Pittsburgh, Pa., which manufactured and erected the structure with its own forces.

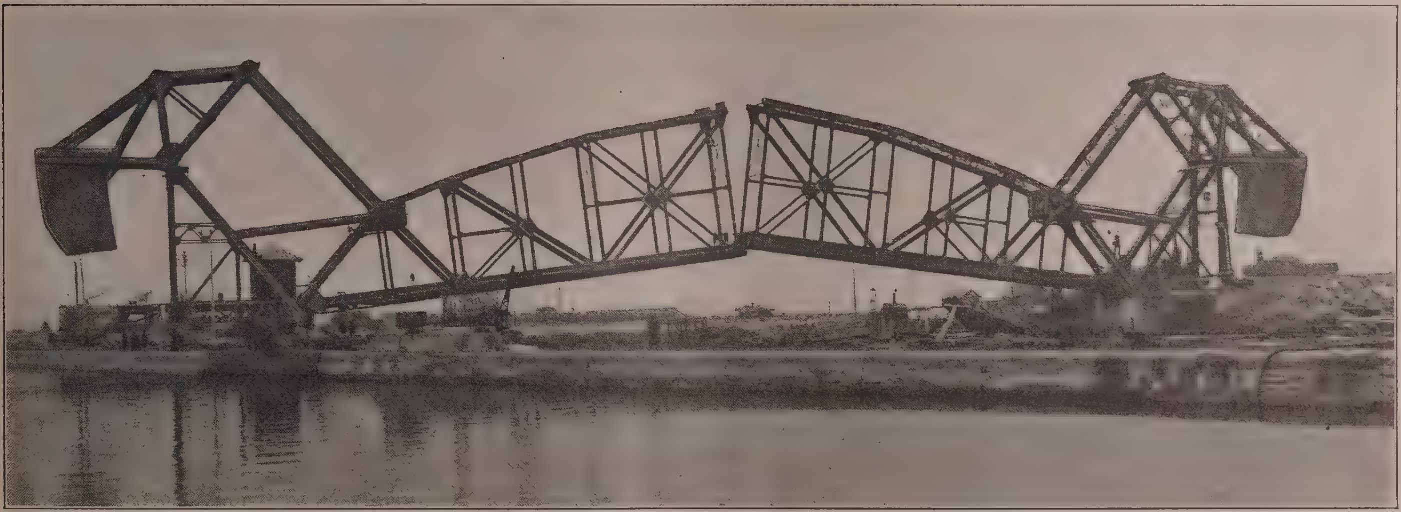
SAND-LIME BRICK has been manufactured in the United States since 1901, and 1913 was a banner year, the value of the product being $1,238,325 or $38,102 more than in 1912, according to a report of the U. S. Geological Survey. Michigan continued to be the leading State, the value of its product constituting 26 per cent of the total value of all sand-lime brick produced in 1913. New York was second in 1913 as in 1912, reporting 11 per cent. Eight States—California, Massachusetts, Michigan, Minnesota, New Jersey, New York, Pennsylvania and Wisconsin—showed increases in 1913 over 1912, and three—Florida, Idaho and Indiana—showed decreases. The average price per thousand for common sand-lime brick was $6.27 in 1913, compared with $6.46 in 1912 and $6.09 in 1911; for front brick it was $10.61 in 1913, against $10.41 in 1912 and $9.53 in 1911.

Sault Ste. Marie Long-Span Bascule Bridge

Double-Leaf, Heel-Trunnion, Single-Track Railway Bridge, with Center Top and Bottom Chord Locks Transmitting Live-Load Stresses

THE record length of 336 ft., center to center, for the double-leaf bascule span of a single-track Canadian Pacific Railway bridge over the new United States ship canal at Sault Ste. Marie, Mich., provides a navigation clearance of 279 ft. The installation of a horizontally movable tower for one of the leaves and special top and bottom chord locks in the center of the channel at the adjacent ends of the two leaves, to provide for the transmission of maximum live-load compression and tension stresses and enable the two bascule leaves to act in combination as a simple fixed span, are unusual features.

The leaves are of the Strauss heel-trunnion type, each having two riveted trusses 168 ft. long and 55 ft. deep, 20 ft. apart on centers. They are counterbalanced by heavy overhead masses of concrete, suspended from the characteristic counterweight trusses connected to the bascule trusses by parallel links. Each bascule leaf complete with floor system weighs about 400 tons and the entire structure, including towers, contains about 1400 tons of structural steel and conforms to the standard design of this type of bascule, except in the special features relative to the transverse adjustment of the towers and the interlocks between the bascule leaves.



Interlocking Devices of Lower-Chord Joints Engaging as Bascule Leaves Are Closed

TOP-CHORD LOCK

The top-chord lock is designed to transmit a maximum compression stress of 1,027,000 lb. and a maximum shear of 320,000 lb. It is made of two steel castings riveted between the chord webs and having principal bearing faces practically normal to the radius from the center of revolution. When the bridge is in the closed position and the bearing pieces are engaged a horizontal section through them shows a tongue-and-groove joint which secures the leaves against relative transverse displacement. The possibility of eccentric bearing of the chords is avoided by the use of a horizontal transverse connection pin, *H*, 6 in. in diameter, which engages half holes in the main casting and provides automatic adjustment for inaccuracies of alignment.

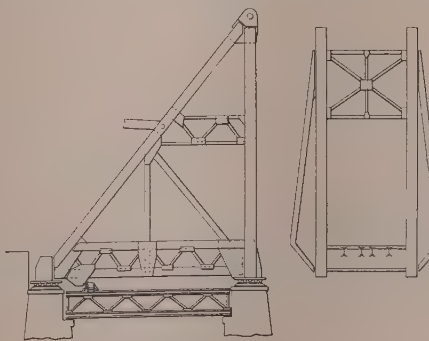
The lock is secured in closed position by a forged steel link hook on each side of each chord, which is pin-connected to one bascule, engages a lock pin in the other leaf, and is normally held in engagement by a spiral spring. This hook, however, is a safety or interlocking device only and is not essential for the proper action of the top-chord lock or hinge.

BOTTOM-CHORD LOCK

The bottom-chord lock also consists of two steel castings pin-connected between the webs of the lower chords of both bascules. In horizontal cross-section one of them has a T-shape head the shoulders of which engage inner bearings in the other casting when the two leaves are brought to the closed position. In other words, the castings have male and female double hooks with carefully fitted bearings and inclined faces, providing increasing clearance beyond the bearings. The pin connections provide for central transmission of the maximum computed central stress of 1,027,000 lb. They also allow for a slight adjustment of the castings by revolution around their centers, which is limited by check pins in slotted holes.

The male portion of the lock is provided with outside horizontal flanges, which engage the outer surfaces of the female part and bring the lower chords to alignment before the male and female portions of the lock engage.

Normally it is intended to operate the leaf having the female part of the joint lock first in opening the bridge and this sequence is determined by the position of the two castings *B-B* bolted between the connection plates just above the locks, as shown. The casting *B*1 is then set with its convex bearing engaging the male lock casting so that the latter cannot be moved vertically until after the female casting has been raised out of position. If it is necessary, through disablement of one leaf, to raise the leaf having the male part of the lock first, this can be provided for quickly by revolving the castings *B* and *B*1 about 90 deg. to the left around their pivots, thus reversing the positions here shown for the castings. This is accomplished by removing the bolts through the upper flange of *B*1, which permits it to be moved out of contact with the male casting. Afterward casting *B* can be revolved until its corresponding convex bearing reaches the position formerly occupied by the bearing of *B*1 and engages the upper part of the female casting. The casting *B* is then fixed in this new position by placing the bolts through the upper flange and the leaves will operate as before, but in reverse order.

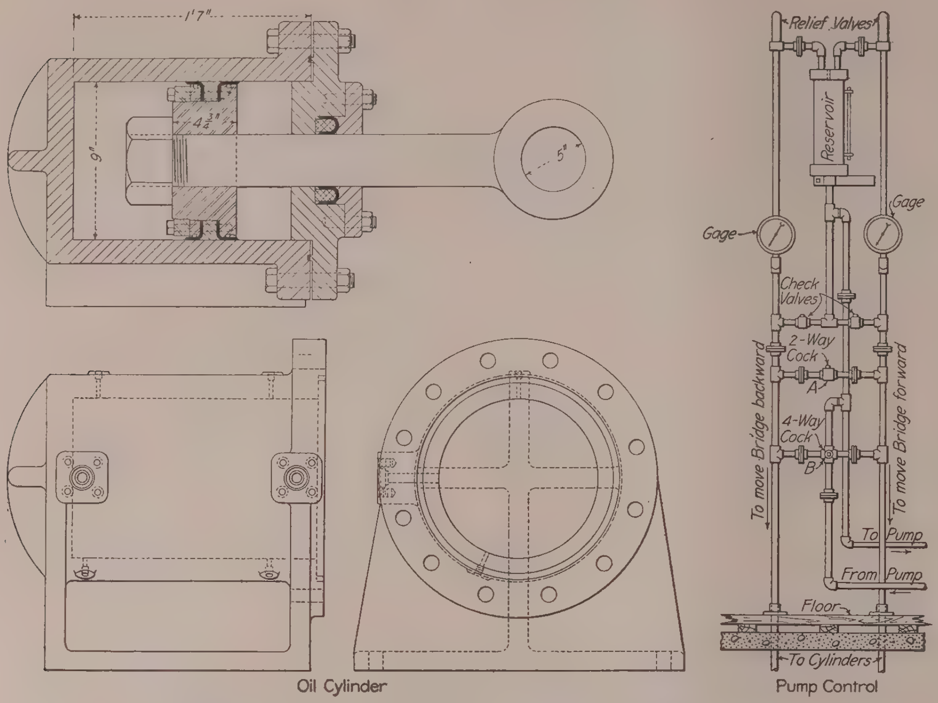


Expansion Tower

Two heavy castings *D-D* are bolted to the connection plates of the opposite leaves above the lock castings and provide on their vertical faces for bearings, which will force the bascule leaves apart if necessary to enable the lock castings to engage, provided temperature changes or other irregularities disturb the proper relative position of the leaves, bringing them too close together. On the contrary, if the leaves have become too much separated the bottom-chord locks will become engaged before the top-chord locks, and the strong tension hooks will pull them together sufficiently for proper engagement.

OPERATING THE BRIDGE

In closing the bridge one leaf is lowered until the lower hinge is at the level of the main trunnion, when the other leaf is brought to the same elevation and the jaws engage. From this point on the leaves are lowered by the operating machinery of the upper leaf, which through the casting *B* or *B*1 forces both leaves into alignment. The top chord lock pin *E* is now revolved by motor-driven mechanism until hook *A* engages the pin *F* and they are clamped by a slight eccentricity of the pivot. The rotary movement is given to the hook by means of a slotted cam, *K*, keyed to the pin



Oil Cylinder

Pump Control

Details of Cylinder and Valves for Moving Expansion Tower

E and bolted to the hook, thus securing the horizontal movement while the hook rests on pin *F*. The bridge is operated from one operator's house and can be opened or closed in one and one-quarter minutes. All of the operating levers are interlocked and their positions and that of the structure are indicated by a simple system of lights.

Movable Tower

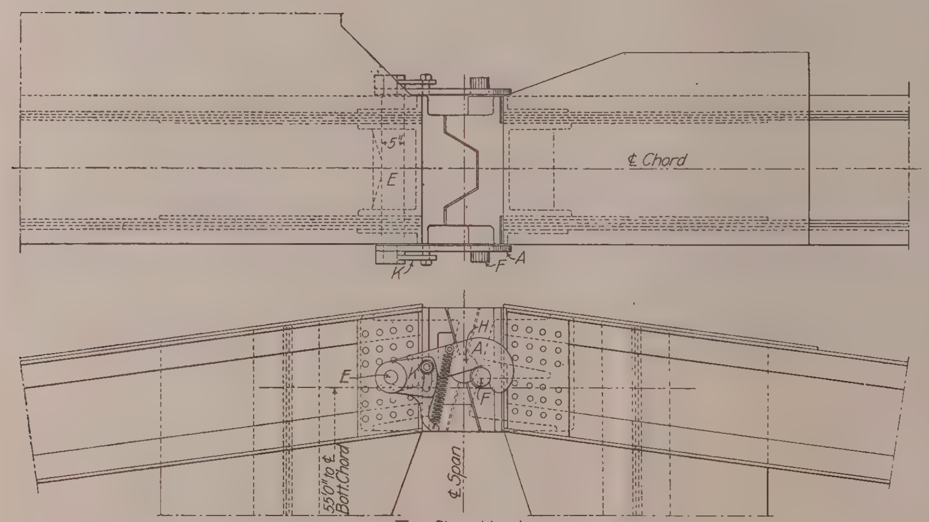
Allowance for contraction and expansion in the superstructure, 426 ft. long over all, including the towers, is made by placing one tower with its leaf and counterweights on rollers, making that end of the span free to move longitudinally when the bridge is closed, provision being made for holding the tower in a fixed position during the operation of the bascule leaves. The movable tower rests on steel roller bearings of a special design suggested by P. B. Motley, engineer of bridges for the Canadian Pacific Railway.

When the bridge is closed and locked the tower is free to move back and forth with temperature variations. Sometimes, as, for instance, if the bridge has been open for a long period during which considerable variation in temperature has occurred, it may be necessary to move the tower before the bridge can be closed. While the leaves are in motion it is always necessary to maintain the tower immovable. The longitudinal movement of the tower is effected by two small oil cylinders installed on a steel frame under the east tower. The plungers of these cylinders engage the underframe of the tower and the cylinders are operated by a hand pump in the operator's house located at the south end of the bridge. By manipulating two valves it is possible to pump oil in at either side of the plunger and thereby move the tower one way or the other, and it is also possible by turning one of the valves to prevent any motion whatever of the oil, which in turn means that no motion of the tower can take place. This latter valve is so interlocked with the electrical machinery of the bridge that the bridge cannot be operated until this valve is closed. An indicator attachment shows the operator whether the bridge has expanded or contracted since it was opened and whether it will therefore be necessary to adjust the position of the tower before closing the bridge.

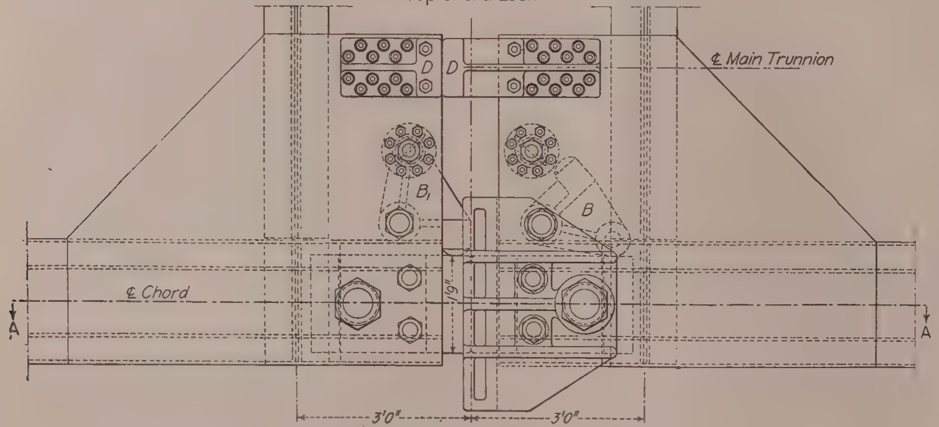
Roller Bearings

Each of the four bearings for the movable tower has a nest of solid cylindrical rollers 12 in. in diameter and about 43 in. long between the shouldered ends, which engage the webs of channels which form two sides of an inclosing frame 11 15/16 in. deep with clearance between the upper and lower half bedplates. The center roller has at each end two diametrically opposite spurs projecting about 2 in. beyond the cylindrical surface to engage recesses in the top and bottom web plates, thus enabling the rollers to rock a short distance either side of the vertical, but limiting its total displacement. This detail is exactly like the standard expansion bearing adopted by the department of bridges of the Canadian Pacific Railway.

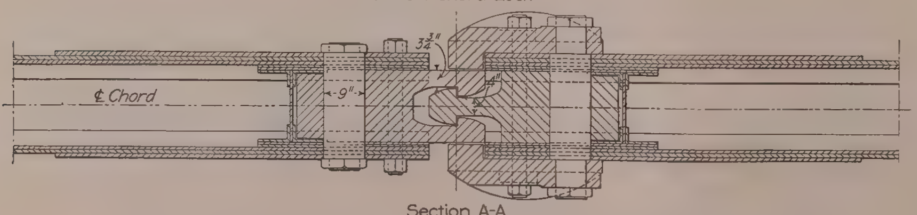
The cylinders are bored 12 in. in diameter and have plungers with an 8¾-in. stroke which are connected by pivoted links to the tower frame. Outlets at both ends of the cylinders provide for controlling the pressure so as to operate the plunger in either direction and to secure a correspond-



Top Chord Lock



Bottom Chord Lock



Section A-A

Top and Bottom Chord Locks for Compression, Tension and Shear

Erecting the Bascule Leaf, Tower Trusses and Counterweight

ing maximum movement of 4¼ in. in the tower displacement. The two pipes from each cylinder are connected to the pressure pump and to a combination of valve pressure gages and compensating reservoir to provide for operation and complete control from one point.

The pump control located in the operator's house at the south tower is commanded by two principal valves, *A* and *B*. When closing the bridge, valve *A* must be opened after the bottom-chord jaws in the leaves have engaged and before the male and female members of the lock have become engaged. While it is open the center lock motor cannot be operated. When the bridge is opened or being opened valve *A* must be closed and it must remain closed, but it must be opened when the bridge is closed in order to provide for the free movement of the latter on rollers.

Valve *B* must be closed when it is necessary to pump the south tower forward or backward. When it is turned one way it will direct the pump pressure to the head of the cylinders and force the tower backward and when reversed the pressure will be directed to the opposite ends of the cylinders, forcing the tower forward.

The reservoir is always maintained about half full of liquid, and since the coefficient of expansion differs materially from that of the steel superstructure and piping, provision for temperature changes is made by two relief valves and two check valves on the inlet and outlet pipes to the reservoir. When the liquid expands the relief valves open and prevent the development of excessive pressure. When the liquid contracts the check valves open and permit the liquid to flow from the reservoir and compensate any deficiency in the pipes, and they also prevent the free passage of liquid from one end of the cylinder to the opposite end.

The position of the south tower is indicated by a pointer which moves about 13/16 in. on the graduated dial for every 5-deg. change of temperature. The normal positions for different temperatures are marked on the dial and when a considerable change of temperature occurs during the period that the bridge is open, the operator should first read the temperature and then, before attempting to close the bridge by working the hand pump, move the south tower until the position of the indicator coincides with the required temperature mark on the dial.

The erection of the 1400-ton superstructure was commenced July 7 and virtually completed in the latter part of September, 1913. As it was required to maintain railroad traffic on the center line of the bridge during its construction, and as the canal was at that time unfinished, the superstructure was erected in closed position on framed falsework trestle bents seated on dry land. Both the bascule leaves and towers were erected by a standard wooden derrick car assembling the floor and lower chords and by a wooden gantry traveler completing the erection of the trusses from one end of the bridge to the other. The 38 x 40-ft. traveler, 62 ft. high, was made chiefly of 12 x 12-in. timber and 3 x 10-in. braces with pin-connected sleeve nut diagonal rods. It had three bents, transverse to the bridge axis, each having four vertical posts, one in the plane of each track rail.

The bridge was designed and constructed under the direction of the Engineering Department of the Canadian Pacific Railway, of which P. B. Motley is bridge engineer. The structure was designed by the Strauss Bascule Bridge Company and the superstructure was fabricated and erected by the Pennsylvania Steel Company.

SIX MILLION DOLLARS a year for roadwork, the sum to be taken from general revenues, is recommended in a report by a special committee appointed in January by the Pennsylvania State Board of Agriculture.

Violet-Ray Sterilization for Niagara Falls Filters

NIAGARA FALLS will have the first municipal ultra-violet-ray sterilization plant in this country. Contract negotiations were consummated June 5 for a 35-lamp installation with the R. U. V. Company, Inc., of New York, to be completed about Sept. 15. "Pistol" lamps, as described in the Engineering Record of Aug. 2, 1913, page 121, will be used, seven in each of five concrete canals, although the company estimates twenty-five lamps only will be required to handle the capacity of the plant, 16,000,000 gal. daily.

The cost of the canals and lamp installations will be $19,800, while the city will erect a building and transformers to change the current from alternating to direct, at a cost of $2200. Approximate costs per 1,000,000 gal. for maintenance are guaranteed as follows: Current, 7 cents; lamp renewals, based on a 2900-hour life, 60 cents.

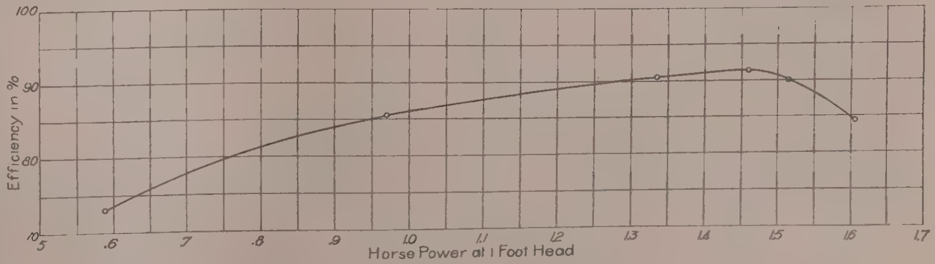
About 1 gr. per gallon of coagulant and 5 lb. of bleach per 1,000,000 gal. have been used at this plant, the total cost of chemicals running about $1.50 per 1,000,000 gal. It is hoped that the coagulant can be cut in half and still give a clear water, in which case the ultra-violet-ray installation will prove economically advantageous.

The channels in which the water will be sterilized will be of concrete, 2 ft. wide, 3 ft. deep and 26 ft. long, affording a contact period of 30 seconds with the ultra-violet rays. The lamps are spaced 30 in. apart and in front of each is a baffle of wired glass in which a rectangular opening is cut to divert the water against the quartz tube.

Waterwheel Model Giving 91.27 Per Cent Efficiency

A TWENTY-EIGHT-INCH-DIAMETER runner of the high-specific speed Francis type gave 91.27 per cent efficiency at 0.749 gate opening when tested in the testing flume of the Holyoke Water Power Company on April 1, 1914. The accompanying curve shows the efficiency of the wheel. This curve is remarkable in several respects not only because of the maximum efficiency being about ¾ per cent higher than the theretofore highest, but because of its flatness. The immediate benefit of this condition is that the runner has about 3½ per cent better efficiency at half-gate opening than any of its predecessors.

The specific speed of this wheel at full load is 65 based on the English system or 290 based on the metric. Judging by recent field tests of large, single runner, vertical units, the designer expects that this runner, installed under a higher head and in large sizes, might show an efficiency of about 95 per cent. The designer of the runner is Chester W. Larner, of the Wellman-Seaver-Morgan Company.



Efficiency Curve of Waterwheel Model and Its Output under a 1-Foot Head

Installation of Construction Plant and Erection of Forms

Building Concrete Grandstand in Thirty-one Days

How Form Drawings Were Tabulated, Organization Systematized, Plant Arranged, Methods Devised and Work Scheduled at Brooklyn Ball Park

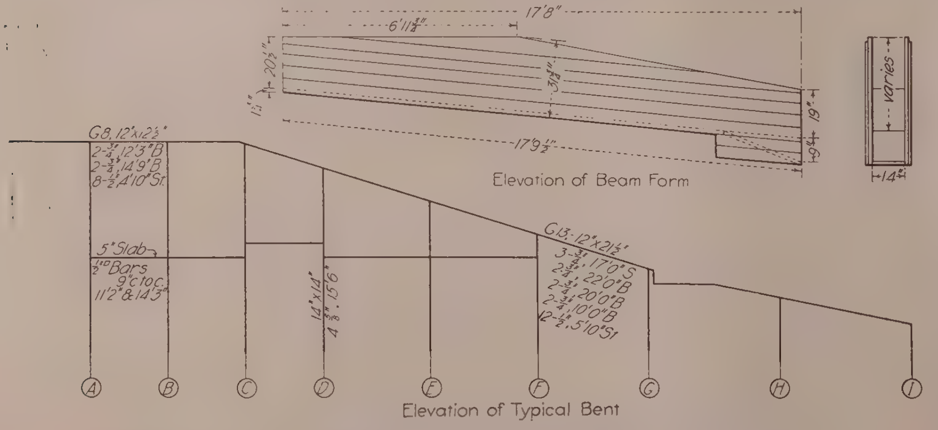
THIRTY-ONE days was the time it took to build the reinforced-concrete baseball grandstand at Washington Park, Brooklyn, a $275,000 structure with a seating capacity of 20,000, involving 7700 cu. yd. of concrete, 360 tons of reinforcement and 292 tons of structural steel. Working drawings, bills and schedules were prepared and the structure was completed in record time by an average force of about 1000 men. Important features contributing to the rapidity of the construction were the tabulation of forms to standard sketches on order sheets, the location of reinforcement steel on standard transverse elevation diagrams of the structure, the development in advance of an organization which classified responsibility for different branches of the work, the preliminary preparation of a schedule of operations—afterward closely adhered to, which governed the sequence and arrangements of different classes of work so that they could be carried on simultaneously without interference and without causing delay—and the arrangement of plant and method of operations.

Simultaneously with the construction of this grandstand another of the same dimensions was built in Chicago from the same design, modified by the substitution of structural steel for reinforced concrete in order to expedite the work, which it was thought could be done much quicker with steel. Both structures were, however, built in the same time. The preparation of working drawings for the Brooklyn structure could not be commenced until after the award of the contract, and was carried on simultaneously with the execution of the work by two draftsmen in the office at the site. No complicated drawings were prepared, and the draftsmen made the bills and sketches in advance of requirements as the work progressed.

Preparation of Drawings

The regularity and simplicity of the beams, girders and columns enabled them to be tabulated so that only a few simple sketches with sets of varying principal dimensions were necessary for the detailing of the forms, thus promoting to a very great degree the accuracy, rapidity and economy of construction. The sketches were made on printed order bills, some of which sufficed for nearly sixty pieces each. A complete set of forms requiring about 800,000 ft. b.m. of lumber were built for the entire structure, and no attempt was made to use any of the forms a second time.

The distribution of the reinforcement in the floor slabs was uniform and required no special drawings. The number, lengths and sizes of reinforcement bars in beams, girders, columns and struts were marked on the diagrams of the transverse bents, like the typical one here shown. All necessary information was thus provided in a compact and convenient form.



Diagrams Used for Tabulated Orders of Girders and Other Members

The rapid execution of the work and simultaneous and orderly completion of different classes of it were largely promoted by the careful organization of the forces and responsibilities shown by the accompanying diagram. In this way the different groups of mechanics and laborers comprising the large force were kept constantly busy without interfering with one another, and the various construction operations were carried on simultaneously without confusion or delay.

Concrete Plant

The handling of the aggregate, distribution of concrete and arrangement of the plant also contributed materially to the continuity and rapidity of the work. Sand and gravel were delivered on scows in the Gowanus Creek, about one block distant, and loaded by clamshell buckets into three 3-yd. Peerless automobile trucks, which transported them to the three mixing machines at the rate of 400 yd. in nine hours. The reinforcement steel and form lumber were stored and the construction of forms was carried on in the space included between the sides of the grandstand. All of the aggregate was delivered and stored outside the grandstand, thus completely separating the concrete operations from form-working. The concrete was handled from three wooden chuting towers 86 ft. high, located so as to command the entire area of the structure and to serve nearly equal portions of it.

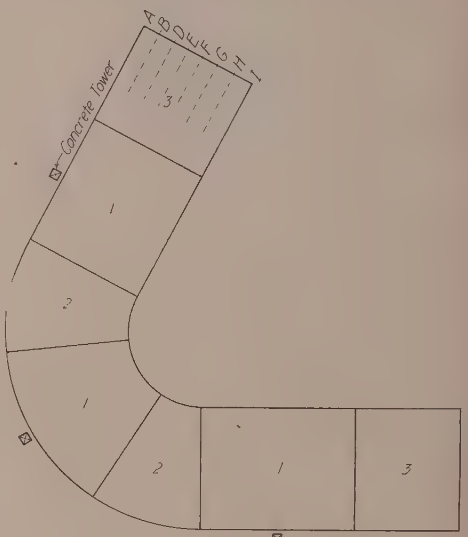
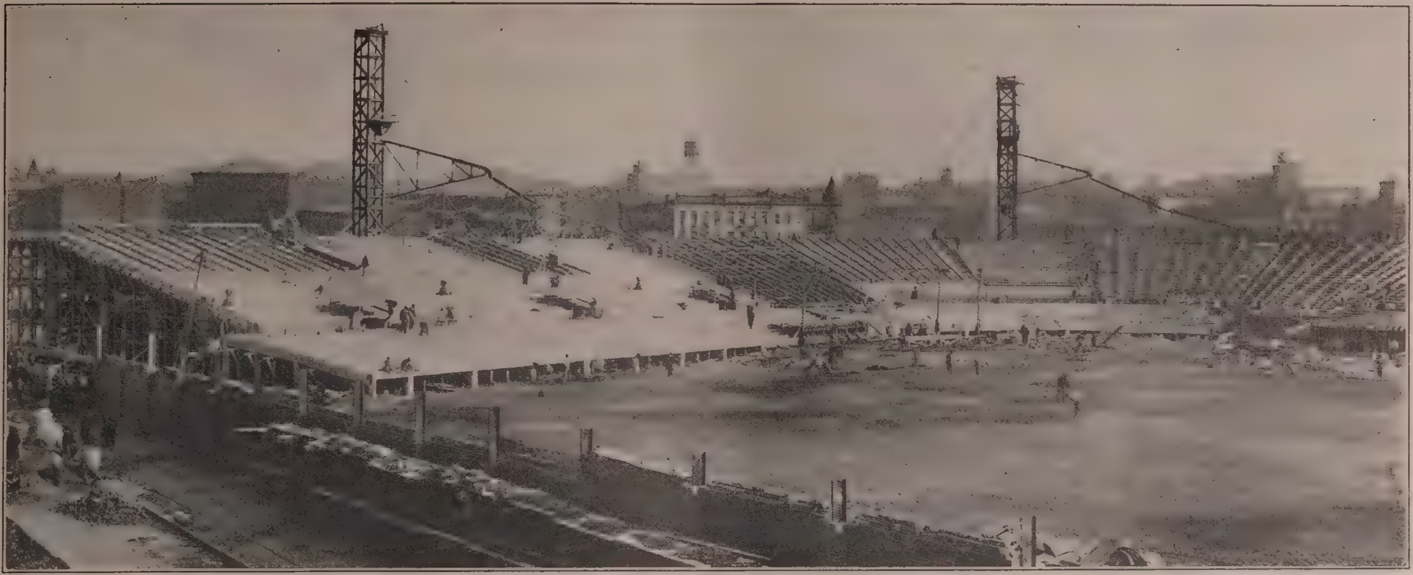


Diagram of Construction Section

The chuting towers were equipped with Ransome mixers and hoists driven by 40-hp. electric motors, and delivered through Wylie chutes, which were built in Oklahoma City, delivered in Brooklyn, and in service on the fourth day after the order for them was received, shipment being made in a special sealed express car.

In the first three days after work was commenced about 500 truck loads of snow and ice were removed from the site. Levels and centers were established, and after the foundation pits were excavated they were enlarged on all sides to double their original area to reduce the foundation loads to the unit values found allowable by soil



Concreting Grandstand Floor Slab with Chuting Towers and Intermediate Hoppers

tests made after the commencement of the work. The pit sheeting was pulled and used for forms. Spoil was wheeled an average distance of 200 ft. and used for grading.

WOODEN FORMS

The forms required about 800,000 ft. b.m. of lumber at an average cost of $26, on which there was a salvage of $8. It was cut up by two electric sawmills on the site. Havermeyer reinforcement bars were received in straight 18, 36, and 54-ft. lengths and bent by hand where necessary. The column forms were built in one, two, and three stories, according to the connections for beams and girders below the deck. The lower sections and the beam forms were filled direct from the tower chutes. The first stories of the three-story columns forms were erected three days in advance of the two-story columns and six days in advance of the one-story columns, to provide for simultaneous concreting of different parts of the deck slab.

The distribution of the concrete to the deck forms was facilitated and controlled and the maximum capacity of the chutes was made available by a system of intermediate concrete hoppers and secondary chutes, which multiplied the area commanded and reduced the quantity of flow at each point.

All operations were carried on in close conformity to a previously arranged schedule, which provided for the beginning and ending of different operations and for the probable number of men, as shown in the accompanying table. These features enabled different portions of the work to be carried on at the required relative speed, so that each portion was as far advanced as possible at any given time and no part of the work was delayed by waiting for materials or for the completion of other work. The grandstand was divided for construction purposes into seven nearly equal portions, which were concreted in the

SCHEDULE OF OPERATIONS ON CONSTRUCTION OF GRAND STAND AND PAVILIONS

Location and Remarks	Classification	Quantity	PRELIMINARY CALENDAR Commence	PRELIMINARY CALENDAR Finish	Time of Actual Completion	—EMPLOYED— Laborers	—EMPLOYED— Mechanics
Foundation	Excavation	4000 yd.	March 11	March 21	March 27	80	5
Footings	Concreting	1500 yd.	March 12	March 24	March 28	70	5
Footings	Backfilling	2500 yd.	March 18	March 26	March 30	25	1
5 teams	Grading	1500 yd.	March 18	March 28	March 31	20	1
Towers	Erection	....	March 11	March 19	March 20	10	12
Reinforcement	Cutting and bending	50 tons, shop	March 17	March 27	March 28	..	8
Reinforcement	Cutting and bending	320 tons, mill	March 25	April 27	April 19	4	25
On ground	General preparation of forms	....	March 13	April 27	April 17	10	60
Section 1	Erecting lower forms	Average force, 120 carpenters, 35 days and 30 helpers 30 days	March 19	March 28	March 24	10	26
	Erecting upper forms		March 25	April 9	April 7	15	40
	Placing lower reinforcement		March 20	April 6	April 10	..	4
	Placing upper reinforcement		March 26	April 9	April 12	..	25
Section 2	Erecting intermediate forms		March 30	April 4	April 4	6	24
	Erecting upper forms		April 6	April 15	April 12	15	40
	Placing intermediate reinforcement		April 1	April 7	April 10	..	5
	Placing upper reinforcement		April 8	April 17	April 15	..	25
Section 3	Erecting end forms		April 6	April 13	April 12	20	30
	Erecting upper forms		April 13	April 22	April 16	20	30
	Placing end reinforcement		April 8	April 15	April 13	..	30
	Placing upper reinforcement		April 14	April 23	April 17	..	25
Section 1	Pouring concrete	2500 yd.	March 25	April 12	April 12		
Section 2	Pouring concrete	1000 yd.	April 8	April 21	April 15	72	6
Section 3	Pouring concrete	1500 yd.	April 13	April 28	April 18	..	..

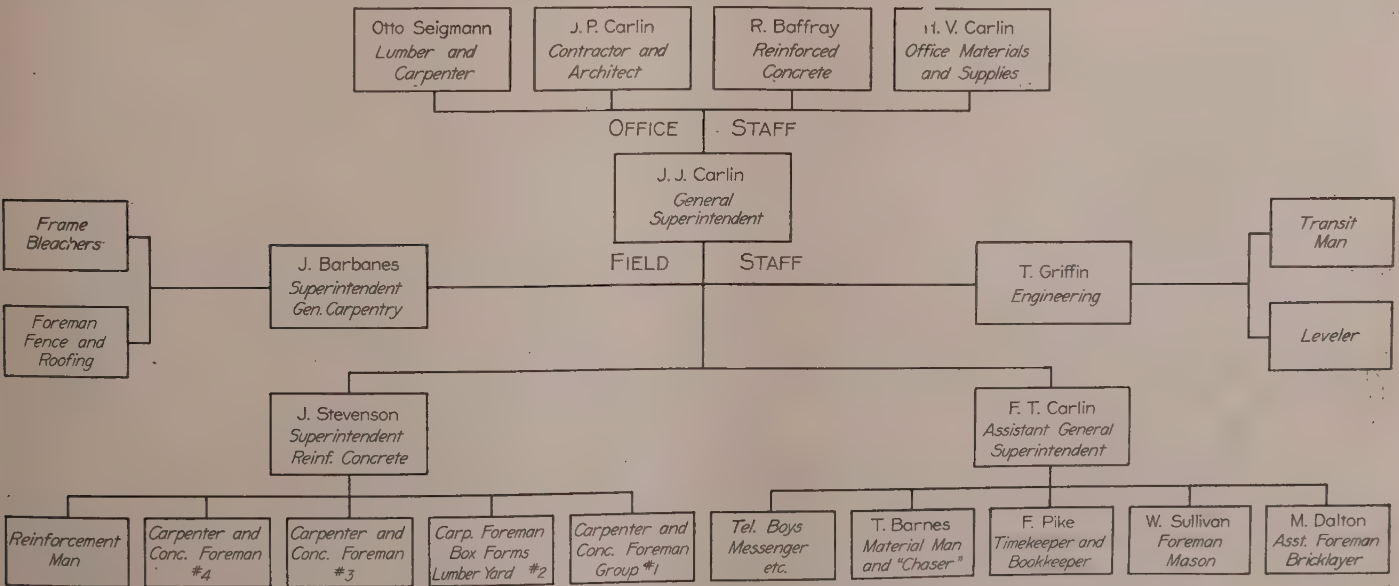
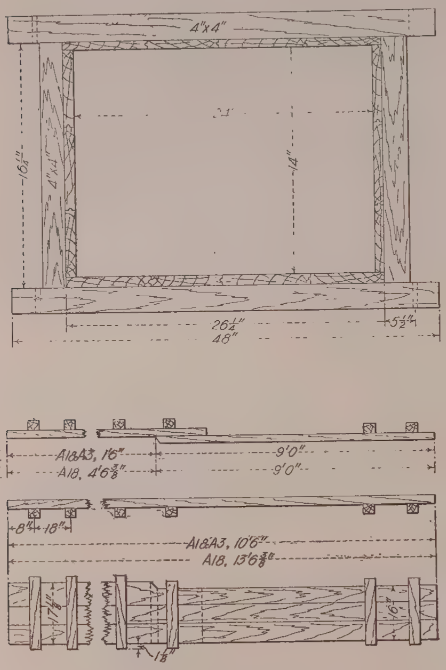


Chart Showing Field Organization Arranged for Great Rapidity of Construction sequence indicated by the various numerals shown on the diagram of construction section on page 702.

Personnel

The structure was designed by Zachary T. Davis and Charles B. Davis, architects, of Chicago; C. B. Comstock, of New York, associate architect; E. C. & R. M. Shankland, of Chicago, and R. Baffery, of New York, engineers. The contract was executed by the P. J. Carlin Construction Company, of New York, of which J. P. Carlin is president; Fred Carlin, superintendent, and J. Stevenson, superintendent of reinforced-concrete construction.



Standard Column Form

Crushing Old Brick to Make Concrete

CRUSHING old brick for concrete used in fireproofing the new city hall in San Francisco has been under way for some time, and the method is reported to give satisfactory results at a low cost. The brick encumbered the site of the old city hall, where great quantities of them have lain since the wreck of that structure in 1906. In preparing the site as part of the new civic center the removal of the brick débris was quite an item, and it was finally decided to make some use of them in the civic buildings. Accordingly, a gyratory rock crusher was installed, which receives brick and the adhering mortar in chunks, just as taken from the ruins and reduces them to 1½-in. size or less. From the crusher, to which wagons dump directly, the material falls upon a bucket conveyor that elevates it to a bin, which in turn feeds by gravity into the wagons. No screens are used, and no trouble has been experienced from excessive lime or brick dust content. The ground brick are used in place of rock in 1:2:4 or even 1:3:6 mixes, the concrete being used only for fireproofing, in slabs, etc. It is interesting to note that legal action against the city for patent infringement has been taken by a company owning patents on a process for fireproofing steel structures by the use of burned clay mixed with concrete.

Changed Plan for Panama Water Supply

DISCOVERY of a steadily increasing chlorine content in the waters of Miraflores Lake, first selected as a source of supply for Panama and the permanent Canal Zone settlements on the Pacific side of the Isthmus, has led, according to the "Canal Record," to the abandonment of this plan in favor of extending the pipe line to the Chagres River at Gamboa. Recent analyses showed a chlorine content as high as 85 parts per million, and it was found that the remote parts of the lake had become impregnated. This degree of salinity, although unnoticeable to the taste, is likely to cause injury to boilers and to render the supply generally unfit for industrial uses.

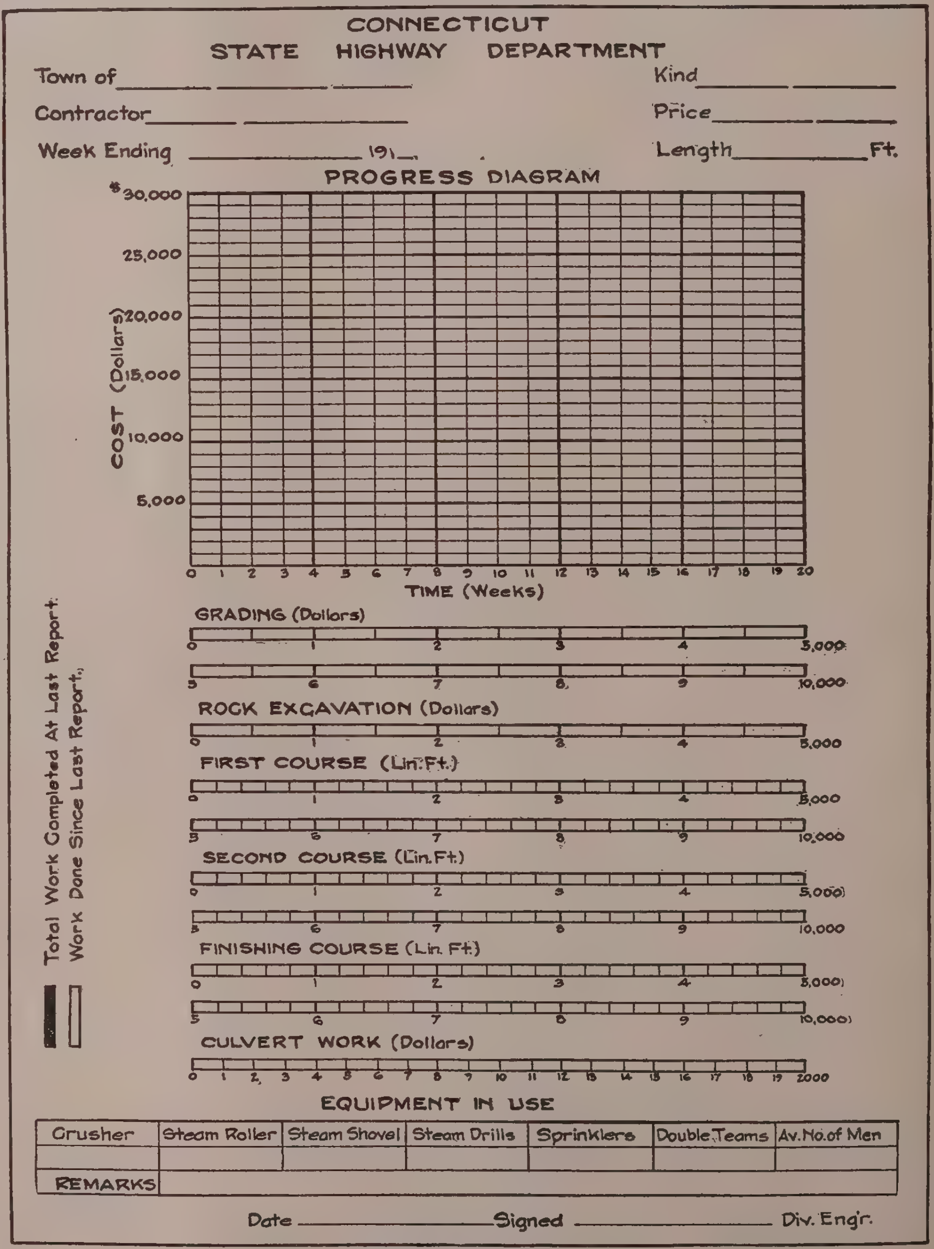
The new plan involves laying about 80,000 ft. of 30-in. cast-iron pipe from Gamboa to La Pita Point, which, at 270 ft. above mean sea level, is the highest elevation between Gamboa and Miraflores; 16,000 ft. of 36-in. pipe from La Pita Point to a point just south of the continental divide, and from there about 26,000 ft. of 30-in. pipe to the Miraflores purification plant. The pumping pressure will have to be about 43 lb. per square inch greater than that at Miraflores to surmount the divide at La Pita, from which point flow will be by gravity. The pipe line will probably be laid on the sides of the railroad embankment where this is stable and in the original ground along the bottom of the embankment where conditions necessitate.

The new pumping plant at Miraflores, partly completed when the plans were changed, seems to be a loss. There will, however, be no change in the equipment ordered and delivered for its construction—such as is still available—or in the electrical equipment already delivered. New pumps for the higher head will be required.

Report System in Connecticut Highway Department

Three of the Blank Forms Used by Inspectors and Division Engineers in Recording Daily or Weekly Progress of the Work

THE three forms reproduced herewith indicate the routine by which subordinates report to the Connecticut State Highway Commissioner, Charles J. Bennett. Each inspector, after collecting the statements



CONNECTICUT
STATE HIGHWAY DEPARTMENT

Town of__________ Kind__________
Contractor__________ Price__________
Week Ending __________ 191_ Length__________Ft.

PROGRESS DIAGRAM

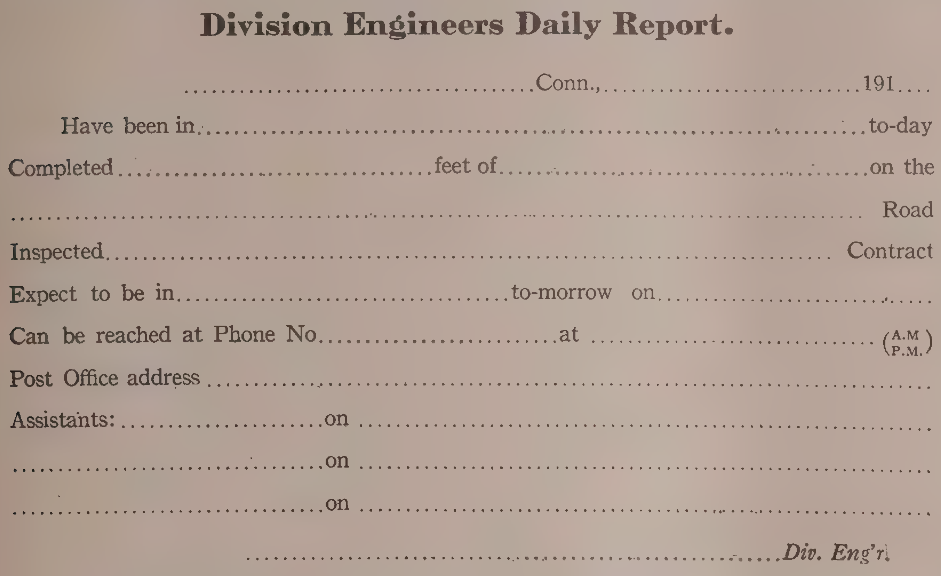
$30,000
25,000
20,000
15,000
10,000
5,000
COST (Dollars)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
TIME (Weeks)
GRADING (Dollars)
0 1 2 3 4 5,000
5 6 7 8 9 10,000
ROCK EXCAVATION (Dollars)
0 1 2 3 4 5,000
FIRST COURSE (Lin. Ft.)
0 1 2 3 4 5,000
5 6 7 8 9 10,000
SECOND COURSE (Lin. Ft.)
0 1 2 3 4 5,000
5 6 7 8 9 10,000
FINISHING COURSE (Lin. Ft.)
0 1 2 3 4 5,000
5 6 7 8 9 10,000
CULVERT WORK (Dollars)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 2000
■ Total Work Completed At Last Report.
□ Work Done Since Last Report.

EQUIPMENT IN USE

Crusher	Steam Roller	Steam Shovel	Steam Drills	Sprinklers	Double Teams	Av. No. of Men
REMARKS						

Date __________ Signed __________ Div. Eng'r.

Weekly Report Form Used by Division Engineers of Connecticut Highway Department of all foremen under his supervision, makes out and signs a form postal giving the data of the work looked over on that day—dividing the work into grading, surfacing and miscellaneous, and giving the force and equipment employed. Each division engineer also uses a post card for his daily report, including, in addition to the combined data furnished by the inspectors, statement of the manner in which he may be reached at any hour of the day. The address side of the card bears the name of the State Highway Commissioner. In a small State like Connecticut this flexible system of post cards, easily made out, is extremely practical and adaptable.



Division Engineers Daily Report.

....Conn.,..............................191....

Have been in..to-day

Completed..................................feet of......................................on the

....Road

Inspected...Contract

Expect to be in..................................to-morrow on..........................

Can be reached at Phone No...........................at ....(A.M / P.M.)

Post Office address ....

Assistants:.......................on ....

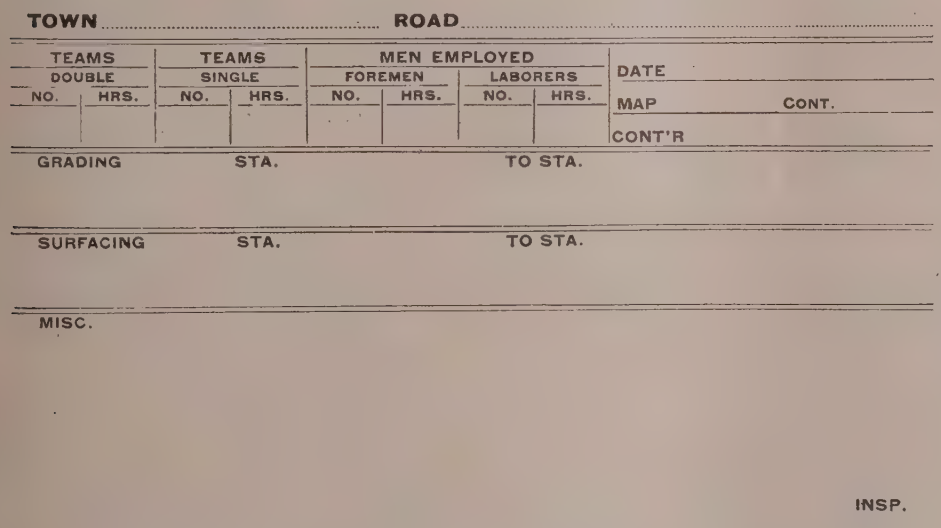
....on ....

....on ....

....*Div. Eng'r.*

Division Engineers' Post-Card Report Addressed to Highway Commissioner

Rather more pretentious, of course, is the weekly progress statement, one copy of which is made out by each division engineer for each contract under his supervision. On the rectangular chart near the top of the sheet may be plotted a curve showing the cost progress of the work on each contract; below is placed a series of linear diagrams of the various elements of construction making up the cost. The two symbols at the left side show the conventions used on these diagrams. These sheets are of letter-page size.



TOWN .... ROAD ....

TEAMS		TEAMS		MEN EMPLOYED				
DOUBLE		SINGLE		FOREMEN		LABORERS		DATE
NO.	HRS.	NO.	HRS.	NO.	HRS.	NO.	HRS.	MAP CONT.
								CONT'R

GRADING STA. TO STA.

SURFACING STA. TO STA.

MISC.

INSP.

Post-Card Report of Highway Inspectors in Connecticut to Division Engineers

There are eight division engineers, the stations being at Winsted, Willimantic, Bridgeport, Middletown, Norwich, New Haven, New Milford and Hartford.

Slow Sand and Mechanical Filter Costs

John H. Gregory Takes Issue with Statements of George A. Johnson in American Waterworks Association Paper

IN discussing the paper "Present-Day Water-Filtration Practice," presented recently by George A. Johnson before the American Waterworks Association, John H. Gregory, consulting engineer, of New York, took issue with the author upon the subjects of sites for filter plants and costs of filtration. Mr. Johnson's paper, published in abstract in the Engineering Record of May 23, page 589, contained figures which indicated that mechanical filters were in most cases preferable to slow sand plants. An abstract of Mr. Gregory's discussion follows:

There is but little question that, under ordinary conditions, the cost of land for slow sand filters will exceed that for rapid sand filters, owing to the larger area required; but that it will amount to as much as twenty times that for slow sand filters, as stated by Mr. Johnson, is open to question. Those who have had experience in acquiring land for waterworks projects know that even if only a small piece of a large tract of land is required for filters the purchaser might often as well buy the whole tract of land as buy only a small portion of it. In acquiring a site for rapid sand filters much more land would be actually purchased than needed simply for the plant. It may be that the area required for the construction of a slow sand filter plant will be twenty times that required for a rapid sand filter plant, but that the land will cost twenty times as much does not necessarily follow.

SITES FOR FILTERS

In discussing further the question of site the author states: "Furthermore, in large projects it is often difficult conveniently to locate a site for slow sand filters, while for a rapid sand filter plant it is a relatively easy matter, as a rule." The inference might be drawn from this that it has been exceedingly difficult to secure sites for large slow sand filter plants, but the history of many of the plants which have been built will hardly bear out this inference.

At Albany, N. Y., practically the first ground available on which filters of either type could be built and which could be purchased at a reasonable price was that on which the slow sand filters were actually built, just north of the city line. At Pittsburgh, Pa., no difficulty was found in securing a site for the slow sand filter plant, which is one of the largest in the world. For the four slow sand plants in Philadelphia—Torresdale, Upper Roxborough, Lower Roxborough and Belmont—no trouble was experienced in securing suitable sites. The Torresdale slow sand filter plant is the largest single plant in the world, and if difficulty had been experienced in securing suitable sites for such works it would naturally be expected to have occurred here. Such was not the case, however, and the plant was built inside the city limits.

One might fancy possibly that trouble would be experienced by the city of New York in securing sites for filters. Such is not the case. More than ten years ago the Commission on Additional Water Supply, in its investigations for an additional water supply for New York City, looked into the question of filter sites not only for the additional supply but also for the Croton supply. Sites were found where slow sand filters could be built in close proximity to the existing Croton aqueduct, and sites for slow sand filters were also found and surveyed where the additional supply could be filtered along the line of the proposed new aqueduct. At Cincinnati, Ohio, the rapid sand filter plant, which is the largest of its kind in operation in the world, was built well upstream above the city, where plenty of land was available for either rapid or slow sand filters. At Columbus, Ohio, the rapid sand filters were built at some little distance upstream above the city. It was a case here of going upstream to get out of the flood zone, although sufficient land for either rapid or slow sand filters was available nearer the city.

SLOW SAND COSTS

It is exceedingly difficult to compare satisfactorily the costs of construction of different plants, even where the fullest information regarding the same is available. Those who are not well posted as to the history of some of the plants cited in Mr.

Johnson's paper may possibly be misled as to the cost of building both slow and rapid sand filters if they accept the figures without full knowledge of local conditions. One of the features which very materially affect the cost of such works is the total reservoir capacity provided—that is, the combined capacity of the settling basins and of the clear-water reservoirs. To illustrate: The rapid sand filter plant at Little Falls, N. J., which in Mr. Johnson's table is the most expensive one cited, and which cost $15,000 per 1,000,000 gal. daily capacity, has a coagulating basin capacity of 1.3 hours and a filtered-water reservoir capacity of 2.6 hours, or 3.9 hours total reservoir capacity. As Columbus, Ohio, the rapid sand filter plant there, which Mr. Johnson states cost $13,000 per 1,000,000 gal. daily capacity—the next to the highest in cost cited—has a settling basin capacity of 12 hours and a filtered-water reservoir capacity of eight hours, making a total reservoir capacity of 20 hours, or five times as much reservoir capacity as that of the Little Falls plant. If the reservoir capacity of the Little Falls plant had been approximately that of the Columbus plant the cost of construction of the Little Falls plant would have been materially increased. The New Orleans rapid sand filter plant has 35.2 hours total reservoir capacity, or practically nine times as much reservoir capacity as that of the Little Falls plant.

ALBANY PLANT

In his reference to the Albany slow sand filter plant Mr. Johnson gives its capacity as 20,000,000 gal. daily. The Albany plant, as originally built before the prefilters were added, had a capacity of 15,000,000 gal. daily. The prefilters increased the capacity of the plant to 28,000,000 gal. daily. If the capacity is taken at 28,000,000 instead of 20,000,000 gal. daily the cost of the plant would be about $14,300 instead of $20,000 per 1,000,000 gal. daily capacity, as given by Mr. Johnson.

The Philadelphia slow sand filter plants were expensive plants to build. They differ in one way from many of the other filters of the same type that have been built in that underneath the filter floors and carried up all around the sides of the filters is a layer of puddle.

In the cost of the Lower Roxborough plant the author did not include the cost of the Lower Roxborough reservoir. A similar condition exists at the Upper Roxborough filter plant with regard to the settling basin. The new Roxborough reservoir was built some ten years earlier than the filter plant, and the author has not included its cost in the cost of the filter plant. Strictly speaking, the costs of the reservoirs should be included.

The Philadelphia plants were built during the régime of very high prices, and to use the costs of construction of these plants to indicate the reasonable cost of slow sand filters may be very misleading except to those who are familiar with the early history of these works and who are aware that the costs were high and that the plants could be duplicated at less cost.

CANADIAN PLANTS

The largest slow sand filter plant under construction in America at the present time is at Montreal, and when completed next year will have a daily capacity of 60,000,000 U. S. gal. The total cost of the plant, on the basis of the lump-sum contract prices, including the low-lift pumping station, will be about $22,600 per 1,000,000 gal. daily capacity. Deducting the low-lift pumping station the cost will probably be about $21,000 per 1,000,000 gal. daily capacity.

It would have been interesting if Mr. Johnson had cited the cost of the slow sand filter plant which was completed at Toronto about two years ago. This plant has a capacity of 48,000,000 U. S. gal. daily, assuming one-sixth of the filter area to be held in reserve and based on a rate of filtration of 6,000,000 U. S. gal. per acre daily, the rate for which the plant was designed. The cost of the plant, omitting the low-lift pumping station, was only about $12,700 per 1,000,000 gal. daily capacity.

In considering the weighted average cost of slow sand filters given by Mr. Johnson—namely, $32,600 per 1,000,000 gal. daily capacity—it may be well to bear in mind that the Montreal plant will cost only about $21,000, that the Albany plant will cost about $14,300 and the Toronto plant only $12,700 per 1,000,000 gal. daily capacity.

RAPID-FILTER COSTS

In referring to the cost of rapid sand filter plants the author cites the Columbus plant as costing $13,000 per 1,000,000 gal. daily capacity. This plant was designed and built under the writer's direction and is a water-softening as well as a rapid sand filter plant. The Columbus plant, considered as a rapid sand filter plant alone, cost nearer $15,000 than $13,000 per 1,000,000 gal. daily capacity, the figure given by the author.

Another rapid sand filter plant which might have been cited is that at Toledo, Ohio, the cost of which was published in the Engineering Record of Nov. 26, 1910. Part of the plant was built for a capacity of 60,000,000 gal. daily, although the present capacity of the works is considerably less. Including only such items as are chargeable to the filter plant proper, the works cost about $14,500 per 1,000,000 gal. daily capacity.

The rapid sand filter plant at Grand Rapids, Mich., was completed inside of the last two years and has a capacity of 20,000,000 gal. daily. The cost of the plant, as given to the writer by the Grand Rapids officials last year, including such items as are chargeable to the filter plant proper, was $16,300 per 1,000,000 gal. daily capacity.

In December, 1912, New York City received bids for a rapid sand filter plant to be located at Jerome Park reservoir and having a capacity of 320,000,000 gal. daily. The writer served as one of a commission of engineers appointed by the Board of Estimate of New York City to report on this plant. Taking the lowest bid received and adding to it the cost of the buildings and other necessary work, the Jerome Park filter plant, which would have been the largest rapid sand filter plant in the world, would have cost about $18,400 per 1,000,000 gal. daily capacity. When the plant is built —and it is greatly to be hoped it will be built soon—the actual cost will probably be in the neighborhood of $20,000 per 1,000,000 gal. daily capacity, as much of the excavation for the plant has already been completed.

CINCINNATI PLANT

Mr. Johnson gives the cost of the Cincinnati rapid sand filter plant, which has a daily capacity of 112,000,000 gal., as $11,400 per 1,000,000 gal. daily capacity, and states that the cost of the large, plain sedimentation basins is not included. The two settling basins cost $1,521,000, or about $13,600 per 1,000,000 gal. daily capacity of filter plant. Adding this cost to that of the filter plant would give a total cost of $25,000 per 1,000,000 gal. daily capacity. As the settling basins serve as storage reservoirs also, it may be reasonable to charge the filter plant with perhaps only half their cost. On this assumption the cost of the settling reservoirs chargeable to the filter plant would be $6,800 per 1,000,000 gal. daily capacity, thus making the total cost of the filter plant $18,200 per 1,000,000 gal. daily capacity.

Still another plant which Mr. Johnson might have cited, and among the best in the country, is that at New Orleans, which has a capacity of 40,000,000 gal. daily. Including only such items as are chargeable to the filter plant proper, the cost of the New Orleans plant was about $30,200 per 1,000,000 gal. daily capacity.

The weighted average cost of the Columbus, Toledo, Grand Rapids, Cincinnati and New Orleans rapid sand filter plants is $18,600 per 1,000,000 gal. daily capacity, while Mr. Johnson gives a weighted average cost for rapid sand filters as $12,100. In other words, the weighted average cost of the five plants just cited—all of which are in operation and which are among the best in the country—is over 50 per cent higher than the weighted average cost given by Mr. Johnson.

The writer is not presenting any brief for slow sand filters. The rapid sand filter is more flexible than the slow sand filter, and in the majority of cases in the United States is better adapted to the purification of water than is the slow sand filter. The slow sand filter has done and is still doing good work in this country, and the present status of water purification is, to a large extent, due to the introduction of the slow sand filter.

Sewer Construction in Victoria, B.C.

THERE is now under construction in Victoria, B. C., a reinforced-concrete trunk sewer about 2 miles in length which is to drain about 425 acres in a rapidly growing residential section of the city, as well as 1000 acres in Esquimalt and 800 acres in Saanich. The sewer starts with a 27-in. diameter and increases to a 36-in. pipe at the outfall near Macaulay point, where tidal currents were deemed favorable for disposal without nuisance. For several hundred feet near the lower end of the sewer steel pipes were used, and were continued to a discharge below water level. The remainder of the line, however, consists of reinforced-concrete pipe, cast in 5-ft. lengths.

In laying the pipe there are required about 3100 ft. of trench, largely in rock, and 7250 ft. of tunnel, practically all in solid rock. The tunnel work is comprised in three separate bores ranging up to 65 ft. in depth below the natural surface, and known as tunnels X, Y and Z. The first of these tunnels is now being driven with the aid of two shafts sunk from the surface above. This tunnel is 7 ft. high by 5 ft. wide, and is being advanced at the rate of about 5 ft. per day. About 135 men are now engaged on the work under the direction of five construction foremen, who report to A. E. Foreman, assistant city engineer under Charles H. Rust.

Wrecking a 250-Foot Reinforced-Concrete Stack at Akron, Ohio

Satisfactory Results of Operations Carried On from an Internal Tower, As Necessitated by Space Limitations

AFTER considering the alternative of felling a reinforced-concrete tower in a space 1 ft. wider than the diameter of the shaft or wrecking it from an internal tower, the latter method was chosen as the more feasible, and, as it turned out, probably the more economical, granting that the chimney could be laid down within the necessary 6-in. clearance. In making extensive improvements to the plant of the Quaker Oats Company at Akron, Ohio, a larger chimney was found necessary on account of greater power requirements in changing many of the units to motor drive and the desirability of centralizing the power output.

Property limitations adjoining the enlarged power house restricted the site of the new 250-ft. stack to the site of the old 218-ft. one. Estimates from $5,000 for wrecking the stack down to about $1,000 for throwing were made by various contractors. To throw the chimney meant cutting it off 30 or 40 feet from the ground, as otherwise the top would wreck a trestle. No means of ascending the stack were available, as the cable passing over a bronze sheave placed by the builders had been broken during a storm. Demolition from the inside was then decided on by the general contractors.

The dimensions of the stack were: Inside diameter at the base, 12 ft. 9 in., and at top, 7 ft.; wall thickness at the bottom, 12 in., and at the top, 5 in. For a height of 75 ft. a lining of radial tile blocks was provided, varying in thickness from 8 to 4 in. and leaving an air space between the lining and the shell of from 8 to 2 in. The stack was reinforced vertically with ⅝-in. twisted rods lapped 3½ ft. at all splices, the spacing varying from 3 in. at the base to more than 3 ft. at the top. These rods were wrapped from top to bottom of the chimney with a single layer of American Steel & Wire Company's 23-mesh wire.

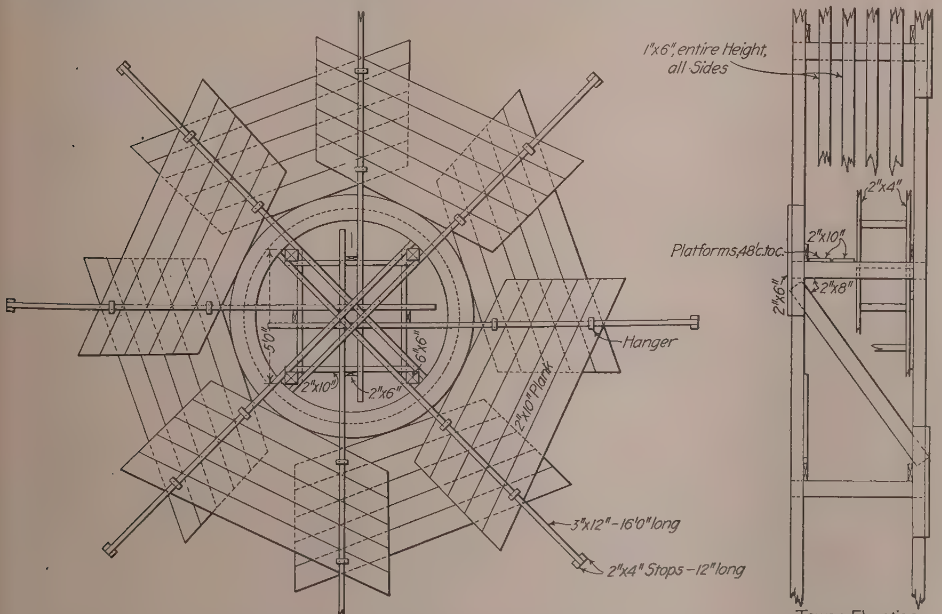
During the wrecking of the stack workmen were constantly engaged in trench work at the base of the chimney in excavating for the foundations of the new addition to the power house, so that unusual precautions were taken to prevent any accidents. Planks were placed over the trenches and a few thrown on the roof of an adjoining building.

A temporary steel stack was first built, enabling the power house to operate, using natural gas as a fuel. The soot was then removed from the base. A 225-ft. tower was built inside the old stack, using material from a dismantled concrete hoisting tower. It carried at its top immediately above the top of the stack the outriggers from which the working scaffold was suspended. Regular bricklayers' scaffold and hangers were used, and one man was kept busy all the time lowering the scaffold as the wrecking progressed.

BREAKING UP CONCRETE

The concrete was broken up with sledges and permitted to fall between the inside of the stack and the tower, the sides of the tower being provided with vertical 1 x 6-in. guard strips to protect the braces, ladders and landings from injury. At all times the scaffold was inclosed with tarpaulin to prevent any injury to the men working below. One man gave his entire time to cutting the wire mesh with a bolt cutter and to tying the ends of the 26-ft. vertical reinforcing rods, so as to prevent their falling when loosened. The rods, which were all saved for use in other work, were lowered to the ground from the outside of the stack. The only accident on the job was occasioned by one of the long rods getting away and falling across the stack, inflicting a slight scalp wound on a workman on the scaffold.

The rods were found to be bright and clean, entirely free from rust. The stack was built in sections about 8 ft. deep, and it was noticed in wrecking that all the joints between sections presented a horizontal plane of cleavage across which the concrete separated with a clean, sharp break. The only cracks found in the entire structure were confined to the 8-ft. bell at the very top. The two largest of the six found showed an opening of nearly ¼ in., disappearing entirely within the depth of the bell. All cracks were vertical.



Scaffold in Highest Position

Tower Elevation at Platform

Outrigging and Scaffold for Wrecking Old Concrete Stack

Every 48 ft. the outriggers were lowered and the upper portion of the tower torn down. This operation required about one day each time and necessitated suspending cutting for part of the day on the upper half, and on the lower half the number of men was reduced, but cutting was not stopped.

Broken concrete and other débris, wheeled in barrows to the fill for a switch track 100 ft. away, was handled by two laborers nights and Sundays. The radial tiles of the lining were saved except for a small breakage and will be used in the lining of the new stack. On the lower 65 ft. of stack it was necessary to use bull points in addition to the sledges in breaking up the concrete, the method being to chisel off 4 to 5 in. of concrete from the outside into the bars, then to batter off the ledge on the inside of the bars with sledges.

Unrusted Reinforcement

Landings were placed every 48 ft., as it was thought that fatigue of the workmen in climbing to the top of the chimney would interfere with their efficiency. No trouble was experienced, however. The foreman went up in four minutes without stopping, but the laborers were ten minutes in making the ascent, taking time for rests at the landings. The tarpaulin at the top was partly to prevent the workmen from seeing out and partly for the protection of the men on the ground. Within a very few days these precautions were entirely unnecessary, as the men became accustomed to their dizzy working quarters.

COST DATA

Laborers were paid 30 cents an hour and carpenters 40 cents an hour. The total cost of wrecking 207 ft. of stack and 75 ft. of lining was apportioned as shown in the table.

Omitting the cost of cleaning out the soot and crediting the salvage, the total cost of wrecking the stack amounts to $5.20 per foot of height. Per cubic yard of concrete and tile removed the cost amounts to $4.50. The salvage amounted to more than 8 tons of reinforcing steel valued at $220, 3000 ft. of lumber, $30, and about 1200 cu. ft. of radial tile blocks, $60—a total of $310.

Liability insurance of $6.48 per hundred was carried in addition to the foregoing

COST OF WRECKING STACK

Cleaning out soot below breeching.......	$21.30
Lumber for tower and scaffold, 8700 ft. b. m.	130.00
Erecting tower 222 ft. high inside stack, building ladders, guard sheeting, platforms, outrigging and scaffold.........	211.27
Rental on bricklayers' scaffold hangers...	100.00
Cutting concrete and wire netting, saving reinforcing rods and radial tile lining..	649.45
Removing débris, 100-ft. haul, and stacking tile and rods.....................	68.25
Lowering outrigging and tearing down tower	202.26
Total	$1,382.53

costs. The tower was started on April 6 and was completed April 18, with three days out for Sundays and rainy weather. The men could not be prevailed upon to work during even a slight rain on account of the flying soot. The cutting and clearing away were entirely completed on May 15, after a further loss of five days for Sundays and rainy weather.

Concrete Stack in Close Quarters Wrecked from Internal Tower

The old stack was built only four years ago, the foundation and first 11 ft. of octagonal base being put in by the Leonard Construction Company in connection with the 1909-1910 improvements at this plant. The circular tapering stack above was built by the Alphons Custodis Chimney Company, which also has the contract for the new stack now building. The Leonard Construction Company, for which H. H. Hadsall had general charge, wrecked the old stack and has the contract for the present improvements, which are being carried out under the direction of O. C. Kirn, chief engineer for the Quaker Oats Company.

ELECTRICAL PUMPING COSTS at Minneapolis during 1913 were $6.851 per 1,000,000 gal. raised against a dynamic head of 263.18 ft. The average cost for electricity per 1,000,000 gal. was $4.372, with the average cost of 0.38 cent per kilowatt-hour. It required 4.37 kw-hr. to pump 1,000,000 gal. 1 ft. high. The average pump and motor efficiency was 71.2 per cent.

Movable Crests for Dams

Types of Automatic and Hand-Controlled Flashboards Proposed to Be Used by the United States Reclamation Service

TYPES of movable dam crests proposed by Gen. William L. Marshall, consulting engineer to the Secretary of the Interior, were described in an article in the May number of the "Professional Memoirs" of the Corps of Engineers, U. S. Army. The accompanying drawings show these crests, which are not all novel. The straight or plane gate type, modified to suit local conditions, has been in use since 1907 on the feeder of the Illinois and Mississippi Canal near the aqueduct crossing Green River. It is placed horizontally in the bottom of the feeder as an emergency stop gate, to rise and retain the canal level in case of a break in the banks. The particular gate was designed by Christopher Holth, mechanical engineer, and constructed by L. L. Wheeler, assistant engineer. The canal bank broke in 1910 and the gate automatically rose and closed the feeder, retaining the level in the feeder canal. It then repaid its cost.

The second type, at the top of the drawing (without the wooden drift shield and siphon), has also been in use since 1907 as upper gates on fourteen locks on the Illinois and Mississippi Canal, but the lower leaves or aprons of those gates were designed of sufficient size only to depress the gates automatically when the locks are filled to within 10 in. or less of the surfaces of the upper pools. Those gates have worked successfully since 1907, although there were defects in workmanship that were corrected, and at least one uncorrected defect in design that is of no practical importance so long as the canal levels are maintained. These gates were also designed under General Marshall's patents by Christopher Holth, but the completed designs were not submitted to him for correction. This type requires flotation or auxiliary power to raise it until its nose is above water, when the current may act. It may be readily modified to be applicable to spans up to 100 ft., but is peculiarly adapted for use as an upper gate to a canal lock of 40 ft. or less span and not exceeding 10 to 12 ft. depth.

NOVEL TYPES

The two types at the bottom of the plate are believed to be novel, and have now been published for what they may be worth. They may be used by the United States freed from patent claims. Any one familiar with bear-trap dams will understand at a glance their working. The only features worth special remark are:

1. The care taken to so arrange the hydraulic chambers as to cause mud and sediment to be swept by the motion of the gate into or near numerous water supply and exit pipes or "scuppers," and sufficient leakage to keep mud from accumulating. This leakage may be reduced to any extent by well-proved means.

2. The arrangement of piping for above purposes, and to secure uniform distribution of water pressures along entire length of gates by making main conduits of much greater capacity than that of all distributing pipes or conduits combined.

3. The siphon for automatic control of the gates during floods, in connection with or rather in addition to hand control. These siphons "bleed' the supply mains before water in them may reach under pressure the small distributing pipes leading into hydraulic chambers, and have discharge capacities nearly equal to but less than the main conduits, so that (if the hand operating devices be closed) whenever during a flood the water level above a dam reaches the level of the siphon throat or top, the siphon at once so "bleeds" the supply main that the preponderance of water pressure is at once changed from one side to the other of the axis of rotation of the gate, and it will fall and remain flat until the level in the reservoir falls below the air inlet to siphon, whereupon the siphon action is broken, the full pressure is again exerted throughout the surface of the gate, the preponderance of pressure is again shifted from one side to the other of the axis of rotation, and the gate rises.

The type with siphon control falling down stream admits trussing or bracing, etc., so that it is possible to make it very light and at the same time strong and stiff against warping and of any reasonable length. It may be advantageously used up to 10 to 12 ft. lift on high spillways and dams. The width of that part below the axis of rotation in any of these movable crests should be not less than five-eighths the width of upper section, exclusive of width of flap leaf; the relative proportions of parts of gates should be computed to meet the special conditions in each case.

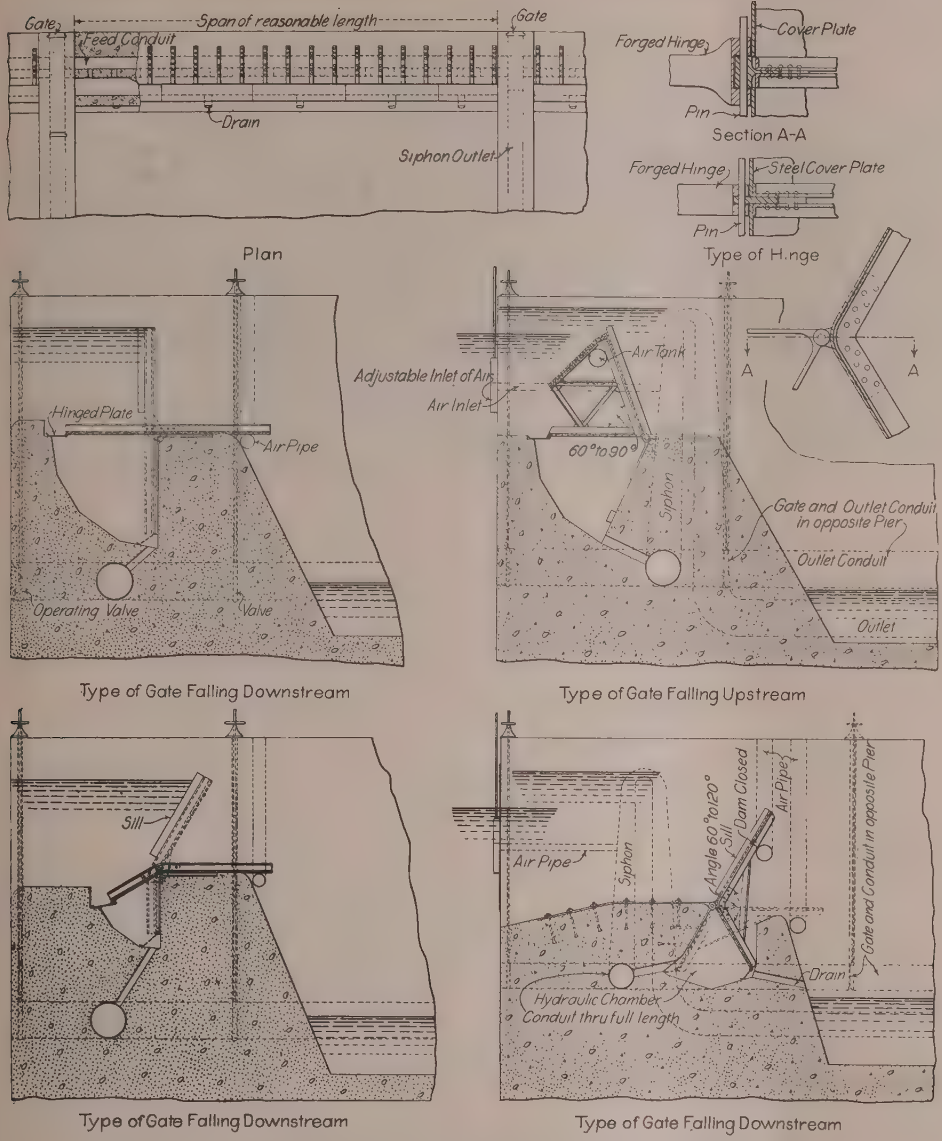
Steel plates are hinged to edges of lower sections and move along inclined planes in order that there shall be elasticity in the system even under considerable wear at axis and inaccurate work. The gates will not be subject to wedging and obstruction by gravel, chips, etc., and these narrow leaves remove most of the objections that have been made to drum weirs, etc., the leaves of which must be nearly in contact with the curved surfaces of hydraulic chambers, and are often wedged. These plates may be in sections of desirable lengths, the joints between lengths may be stopped against leakage by strips of pure rubber packing, allowing any section to rise or descend enough to pass over any chance pebble or chip without serious leakage, or straining the gate, and the plates as a whole to adjust themselves to wear or inaccurate workmanship, location of axis or in forming the plane surfaces of the hydraulic chamber.

4. The air passages to remove vacuums that form under the gate, due to rapid flow of water over it when down, are not novel except in the particular disposition of them. Vacuums more or less complete under overfalls increase materially the pressures on the upstream faces of gates and dams; cause tremblings and vibrations in dams, and in old bear-trap forms sometimes determine whether they can be worked at all in certain positions or phases of their motion.

The question of prevention of partial vacuums, then, is of some importance in all dams, whether movable or fixed, and especially so in bear traps, where little or no attention has been given the subject.

REGULATION OF RESERVOIR LEVELS

Some criticisms of automatic movable sluice gates have been based upon the opin-



Type of Gate Falling Downstream

Type of Gate Falling Upstream

Type of Gate Falling Downstream

Type of Gate Falling Downstream

Plan, Sectional Elevations and Details of Movable Crests for Dams

ion that their movements are so rapid that there would be thrown into the stream below the reservoir large amounts of water en masse, thus creating waves of such magnitude that damage to animal life, or to property, might result.

This objection is well founded, but, when it is considered that the movable crests, or spillway gates proposed are in fact hydraulic engines, capable, if properly constructed, of as smooth, gradual and certain movement and control (and by similar methods) as any other hydraulic press or engine, the point is of small importance.

It is necessary for this purpose in a series of sluiceways controlled by automatic gates to provide one and only one sluiceway of the series, with a hydraulic gate to be operated carefully by hand, in order to make the increase in discharge as gradual as it would be over a fixed or movable horizontal weir of suitable length, by filling in by gradual increase in discharge the differences in total discharge caused by the sudden periodic gate movements.

For instance, suppose there is an available site 350 ft. in length for a spillway to be used in connection with a large reservoir, and that the maximum flood to be wasted is about 25,000 sec.-ft. and it be desired to store all water practicable in the reservoir, with a fluctuation in its water level of about 2 ft.

The effective depth of the sluiceways, if 50 ft. wide each, must be 9 ft. at maximum flood level, and there must be six of such sluiceways of that width to discharge the maximum flood of 25,000 sec.-ft.

The sluice gates or movable crests may be made of 7-ft. lift each, and the water levels in the reservoir must be so controlled as to rise not more than 2 ft. above their crests when raised.

Each 50-ft. sluiceway 7 ft. deep will discharge approximately 3000 sec.-ft. When the water rises to the limit assumed there will be 9 ft. depth in the sluices and the discharge of each will then approximate 4500 sec.-ft. The discharges may be less than above given, but they are assumed for the purposes of a demonstration; accuracy is not now in question.

One of the sluice-gates is to be of most careful construction, and fitted in all its parts for hand control and operation, and five of them are supposed to be operated automatically by siphon, all gates being of a type falling down stream from the reservoir. These latter have the siphon throats and their air-entrance breaks adjusted in level so that the gates will fall in succession, upon increments of say about 3 in. in reservoir levels, beginning with the first gate falling when that level reaches 7 in. above the crest when raised, and the last or sixth gate falling when the water level of the reservoir is about 3 in. below the maximum safe limit named above. Now, when the water level in the reservoir rises until it is nearing 7 in. above the crests of the gates—at which level the first gate is arranged to fall—the operator would begin to lower the hand-operated gate at a rate that preserves the level of the reservoir water until that gate be fully depressed.

Whenever the first automatic gate goes down, the hand-operated gate should at once be raised, and the same gradual movement of the hand-operated gate be resumed between the falling of the first and second, etc., and succeeding automatic gates, if such care be necessary. It is, then, practicable to make the discharge from a reservoir by the use of these gates, or indeed of any of the "bear-trap" family, as gradual and regular as by any other device, even if that device be a fixed weir, but the controlled sluiceways have the material advantage over the fixed weir of allowing the storage of 7 ft. (in this case) depth of water over the entire surface of the reservoir, which cannot be done by a fixed weir of same length of crest with as little waste and as little fluctuation in water level in the reservoir, and the sluices moreover, serve admirably for drift chutes.

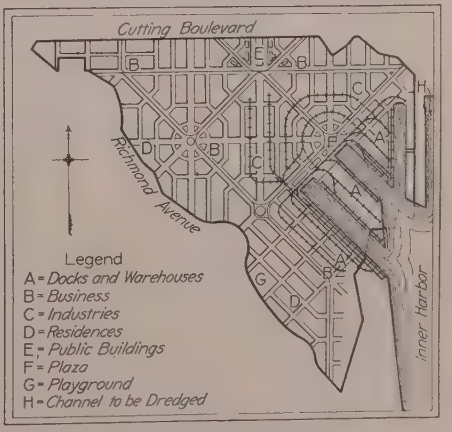
In some very large reservoirs now in existence, or under construction, this additional storage of 7 ft. in the reservoir might run to a hundred thousand acre-feet or even much more, a matter of very great importance in our arid region, where water is so precious for irrigation and domestic use.

Richmond City-Planning Awards

Prize Designs Out of One Hundred and Forty-Six Plans Submitted by Engineers and Architects Throughout the Country

AWARDS have been made as follows in the Richmond (Cal.) city-planning competition:

First prize, $5,000, to Arthur C. Comey, landscape architect, Cambridge, Mass.; five second prizes of $1,000 each, to Taggart Aston, civil engineer, San Francisco; Philip W. Foster, landscape architect, Cambridge, Mass.; Berthold Wuth, assistant county surveyor, Oakland, Cal.; L. A. de Milt, Jr., landscape architect, Indianapolis, Ind., and W. S. Farley, civic engineer, Stege, Cal. The authors of eight other designs out of 146 submitted received honorable mention. C. E. Grunsky, formerly city engineer of San Francisco, was a member of the jury making the awards, the other



First-Prize Design

four members being Charles D. Heywood, mayor of Berkeley; C. F. Michaels, president of the San Francisco Chamber of Commerce; Louis C. Mullgardt, president of the San Francisco Society of Architects, and C. H. Cheney, city planner and adviser to the competition.

The property consists of 350 acres located at the end of the new inner harbor at Richmond. It was necessary for the contestants to consider and solve the problem of docks, shipping facilities, a business district and railroad and water approaches.

Report on Plan of Refuse Disposal in St. Paul

RECOMMENDATIONS as to the best method of disposing of the garbage and refuse of St. Paul, Minn., have been presented to the mayor and council committee by a sanitation committee of which George H. Herrold, office engineer of the Department of Public Works, was chairman. Municipal intead of private collection is advocated. It is estimated that the city of St. Paul will produce daily 80 tons of garbage, 64 tons of rubbish, 26 tons of street sweepings and 140 tons of ashes, or approximately 170 tons of burnable material and 140 tons to be taken to the dumps.

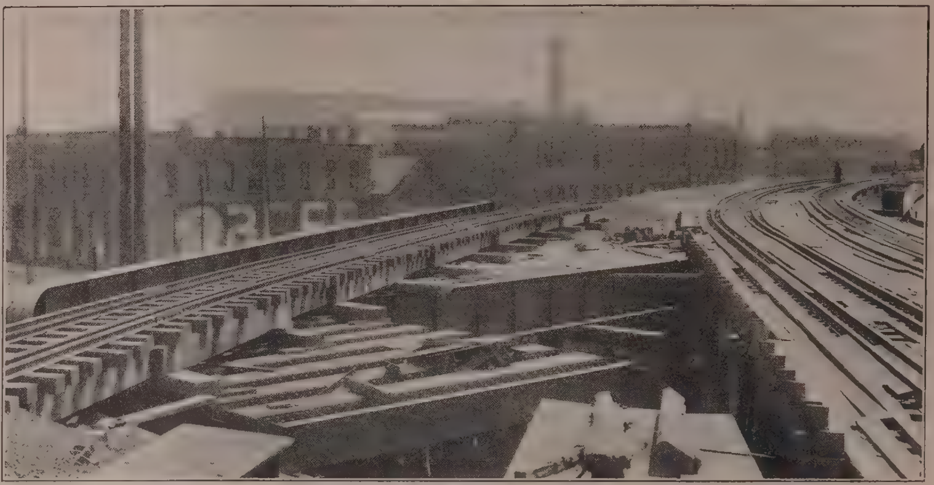
It is recommended that the city be divided into four districts and that incinerators be constructed in each district, one of 80 tons capacity in the downtown district and three of 40 tons capacity in the out-

Using the tentative location for the downtown incinerator, the district bounded by a circle which has a radius of 1½ miles contains a population of 80,000 and will produce approximately 70 tons of burnable refuse—30 tons of garbage, 24 tons of rubbish and 16 tons of street sweepings.

An 80-ton incinerator, two 40-ton units, with a 150-hp. boiler, brick chimney, brick or concrete building, tile roof and approach bridge, all of pleasing architecture, can be built, according to the report, for $55,000. The operating expense of such an incinerator while running at full capacity would be:

12 stokers, four for each eight-hour shift at 25 cents	$24
3 dump men, one for each eight-hour shift at 25 cents	6
3 engineers, one at $125, two at $90	10
Total	$40

This plant will generate steam for 150 hp, using refuse only as a fuel. Using nish 4500 lb. condensation per hour, or, turning it into electrical energy, 110 kw per hour.



Loss of Space During Construction Caused by Skew of Bridge

Pennsylvania Track Elevation and Grade Separation at Cleveland

Two-Mile Improvement in Which Design and Construction Were Hampered by Heavy Traffic and Narrow Right-of-Way

A TWO-MILE program of track elevation and grade-crossing elimination on the Pennsylvania Lines West of Pittsburgh at Cleveland, in progress for the last two years, is nearing completion. The work, which involved fourteen street crossings, was complicated by the heavy traffic on the railroad and at most of the streets, the narrow right-of-way, the skew of the streets, necessitating complicated arrangements of temporary timber trestles and of permanent steel structures and the low head room at some of the crossings, on account of which the temporary trestles had to be built above the final grade to permit the passage of street cars before excavating for the street depression. The work of necessity had to be done piecemeal, one or two tracks being raised at a time. It was also necessary to reconstruct the Euclid Avenue station and replace the old freight house at that point with a new layout. The bridges are in general of the ordinary plate-girder and trough type, but a material saving in concrete in the bridge floors has been effected by hollow construction in the troughs.

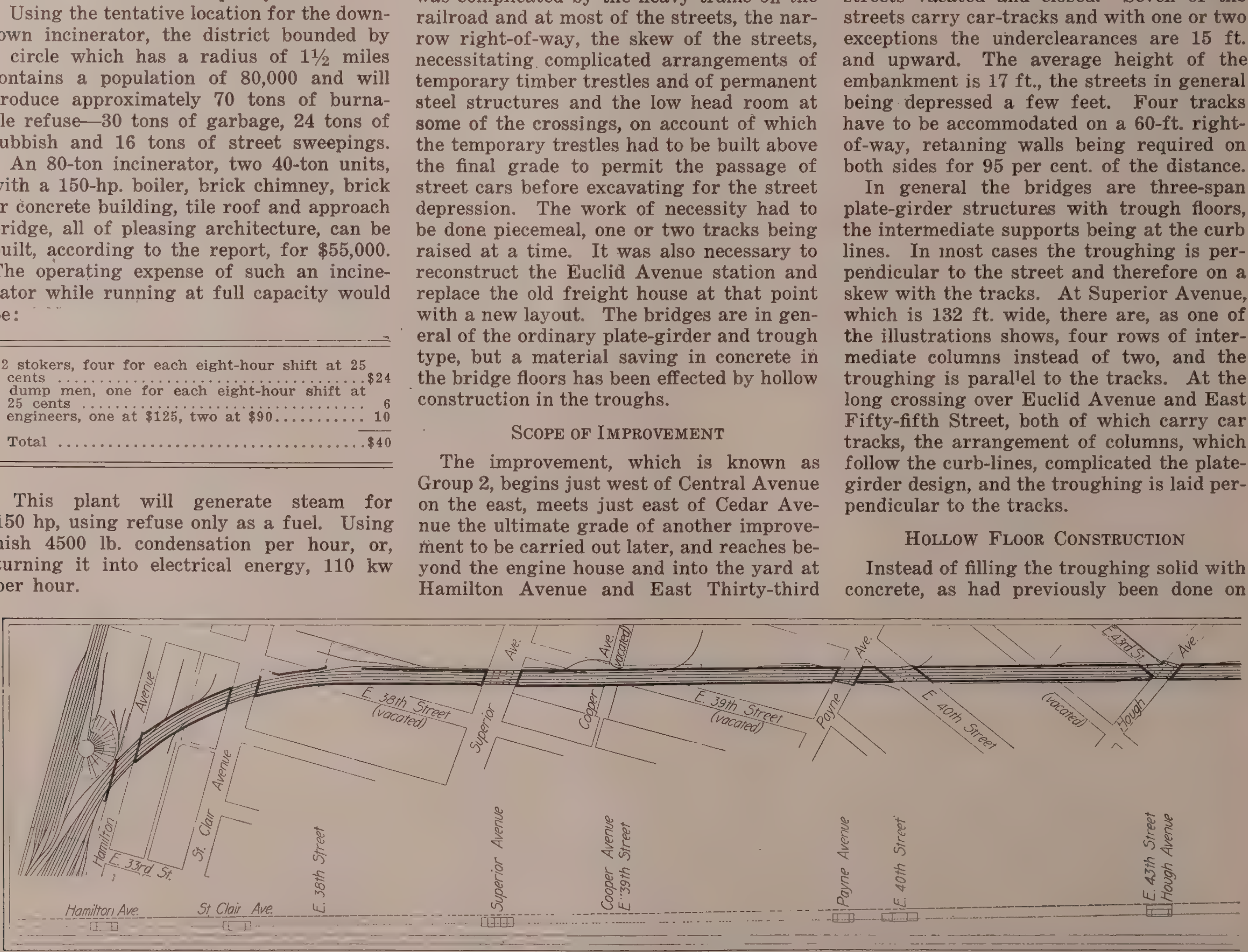
SCOPE OF IMPROVEMENT

The improvement, which is known as Group 2, begins just west of Central Avenue on the east, meets just east of Cedar Avenue the ultimate grade of another improvement to be carried out later, and reaches beyond the engine house and into the yard at Hamilton Avenue and East Thirty-third Street. Aside from the passenger and the baggage and freight subways at the Euclid Avenue station there are eleven bridges, which accommodate thirteen streets, two streets being brought under one bridge at each of two points. There are also four streets vacated and closed. Seven of the streets carry car-tracks and with one or two exceptions the underclearances are 15 ft. and upward. The average height of the embankment is 17 ft., the streets in general being depressed a few feet. Four tracks have to be accommodated on a 60-ft. right-of-way, retaining walls being required on both sides for 95 per cent. of the distance.

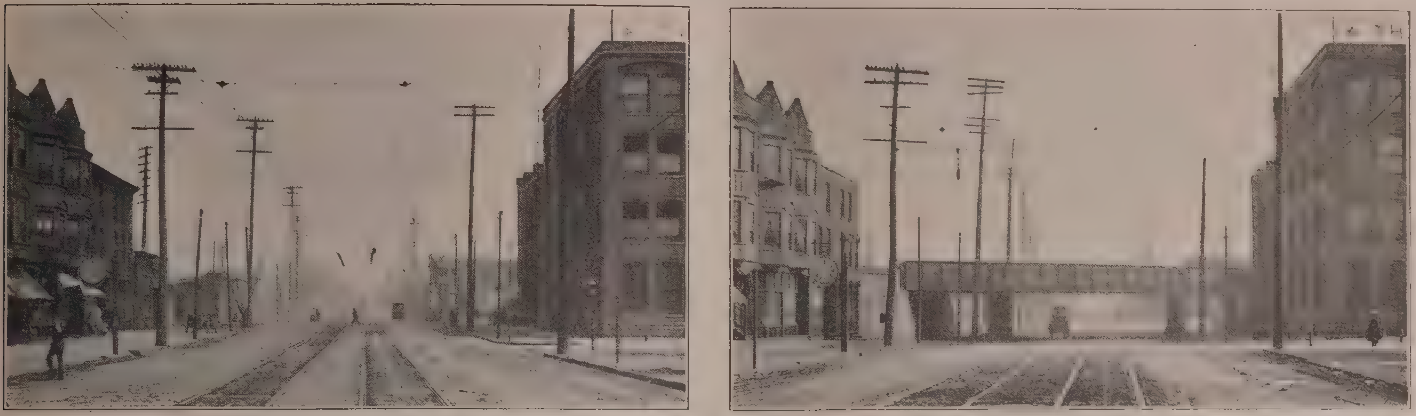
In general the bridges are three-span plate-girder structures with trough floors, the intermediate supports being at the curb lines. In most cases the troughing is perpendicular to the street and therefore on a skew with the tracks. At Superior Avenue, which is 132 ft. wide, there are, as one of the illustrations shows, four rows of intermediate columns instead of two, and the troughing is parallel to the tracks. At the long crossing over Euclid Avenue and East Fifty-fifth Street, both of which carry car tracks, the arrangement of columns, which follow the curb-lines, complicated the plate-girder design, and the troughing is laid perpendicular to the tracks.

HOLLOW FLOOR CONSTRUCTION

Instead of filling the troughing solid with concrete, as had previously been done on

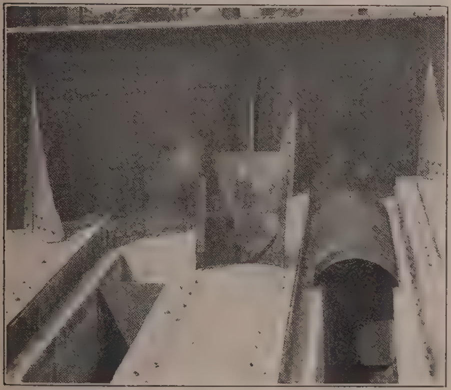


General Plan and Profile of Improvement, Showing Skew and Column Arrangement of Crossings, Location of Improved



St. Clair Avenue—Typical of Most of the Crossings—Before and After Elevating the Tracks

similar work, a material saving in concrete and, more especially, a considerable decrease in dead load have been effected by providing only a 4-in. lining, the hollow space being arched over at the top. The method of procedure is shown clearly in one of the illustrations. A 4-in. layer of concrete is first placed in the bottom of the trough. Collapsible steel forms are then placed in the trough, being so designed that they will allow a 4-in. wall of concrete on each side of the trough. When this concrete is brought to the level of the top of the form the form is removed and the steel arch form, the top of which is, when in place, level with the top of the trough, is set. This remains when the concrete is placed above it.

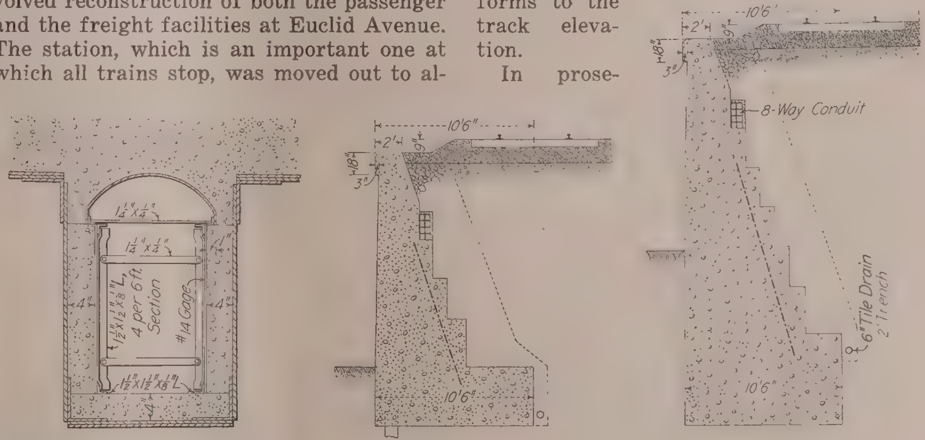


Forms for Hollow Floor Construction

The abutments are of mass concrete with plumb faces and ornamental paneling. Owing to the narrow right-of-way the retaining walls had in general to be placed on the right-of-way lines, which made it impossible to use a projecting toe. This difficulty is overcome, therefore, by using concrete piling and a heavy and broad footing projecting inward under the tracks to resist overturning. Typical sections of these walls are shown, from which it is seen that the width of this footing is 10 ft. 6 in. irrespective of the height of the wall; also that the wall, whatever the height, has a batter of 3 in., which is taken up in the overhang of the coping.

EUCLID AVENUE FACILITIES

As already stated the improvement involved reconstruction of both the passenger and the freight facilities at Euclid Avenue. The station, which is an important one at which all trains stop, was moved out to allow spreading of the tracks, and an ornamental concourse was built between station and tracks, from which the platforms are reached by the passenger subway and stairways.



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$1\frac{1}{4}'' \times \frac{1}{4}''$
$1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ L, 4 per 6 ft. Section
#14 Gage
4"
4"
1"
4"
$1\frac{1}{2}'' \times 1\frac{1}{2}'' \times \frac{1}{8}''$ L
10'6"
2'
9"
18"
3"
10'6"
10'6"
2'
9"
18"
3"
8-Way Conduit
6" Tile Drain
2' Trench
10'6"

Hollow Construction in Troughs

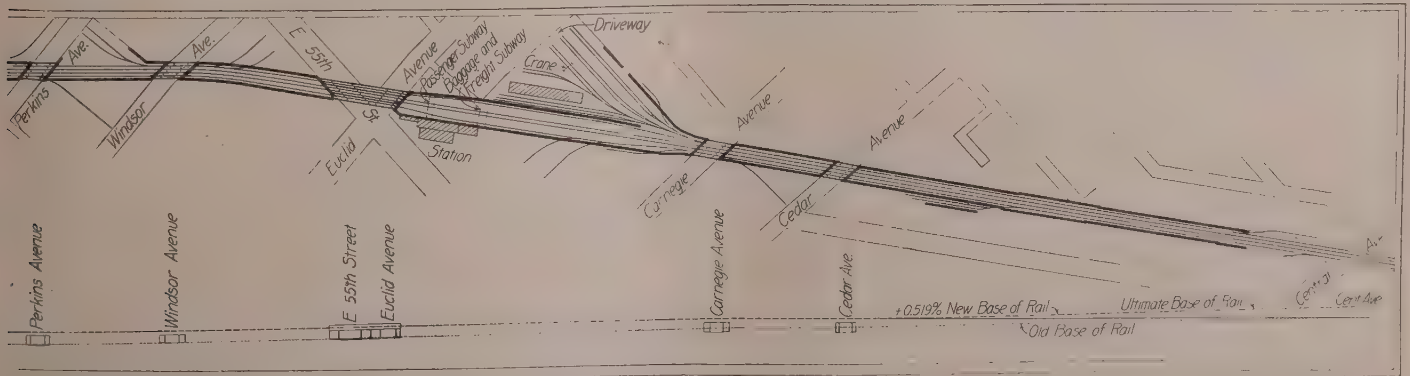
Typical Cross Sections of Retaining Wall

Details of Retaining Walls and Hollow Construction in Troughs

The old freight house was just east of the station on the same side of the tracks. In the new layout on property acquired on the north side are a freight house, 295 x 40 ft., served by three tracks, and a team yard of eight tracks, two of which are served by a gantry crane. The new layout has a capacity of 85 cars, and is at an intermediate elevation between the old ground level and the main-track level.

In addition to these changes there are numerous industries on both sides of the tracks, for which siding facilities had to be readjusted. As these are in general close to the tracks and no space was available for long approach tracks, the industries had, in general, simply to accommodate their buildings and platforms to the track elevation.

In prosecuting the work there were the usual problems found in elevating tracks under heavy traffic on a narrow right-of-way, necessitating abandonment of one or two tracks at a time, replacing them on elevated temporary trestles, building the retaining walls and sections of the abutments under and around the trestles, and repeating the process with the remaining tracks. On this improvement there was introduced the further complication, not found in track-elevation work where the intersecting



Local Freight Layout, Industrial Spurs and Streets Vacated, and Extent of Retaining Walls streets cross at right angles, of the skew of the steel work and troughing. The view of the St. Clair Avenue bridge shows the necessary sacrifice of valuable space to allow the placing of the steel. This virtually necessitated abandoning one of the middle tracks and shifting the other back and forth as the work proceeded. It also necessitated great care in the design of the trestle work to avoid interference with the placing of enough steel to permit the next shift.

The Brownell Improvement Company, of Chicago, has the general contract for the temporary trestles, the street grading and the concrete. Filling under tracks has been done by company forces. The steel work is being furnished by the Fort Pitt and the King Bridge Companies, of Pittsburgh and Cleveland respectively, and erected by the Strobel Steel Construction Company, of Chicago. The work is being carried out under the general direction of Robert Trimble, chief engineer maintenance-of-way, Northwest System, Pennsylvania Lines West of Pittsburgh, and H. W. Petersen, engineer in charge at Cleveland.

Book Reviews

Bulletin 57 of the U. S. Bureau of Mines, "Safety and Efficiency in Mine Tunneling," by David H. Brunton and John A. Davis, has just been published. It comprises 235 pages, with illustrations, and deals with provisions for the safety of employees, kinds of equipment, methods of driving and costs of construction. The text is not confined to mine tunnels, but treats of railroad, aqueduct and drainage tunnels, including those on the Catskill and Los Angeles aqueducts. The book is based upon a special examination of tunnels throughout the country, made by the Bureau of Mines in 1911 and 1912. It abounds in useful information, is written in an interesting style and should be a welcome addition to the library of every engineer whose work takes him underground.

INSPECTION OF CONCRETE CONSTRUCTION. By Jerome Cochran. Cloth, 6 x 9 in.; 595 pages; 26 illustrations. Chicago, Myron C. Clark Publishing Company. $4 net.

(Reviewed by F. H. Constant, Professor of Structural Engineering, University of Minnesota, Minneapolis.)

This book follows in close succession the work on concrete specifications reviewed in these columns in the issue of March 21. The present volume includes 595 pages of small-type print. The headings of the chapters will indicate its scope.

The introduction discusses in a general way the inspection of concrete construction, the duties and training of inspectors, the important details in the erection of structures, and the cause of failures. Chapter 1 covers cement testing and inspection; chapter 2, the inspection of sand, stone and other concrete materials; chapter 3, the inspection of proportioning and mixing concrete; chapter 4, forms, molds, centering and falsework; chapter 5, steel reinforcement, and chapter 6, the inspection of concrete, including such subheadings as transporting, placing, puddling and ramming concrete, bonding new to old work, contraction joints, patching defective work, efflorescence, concreting at high and low temperatures, depositing through chutes or under water, cinder and asphaltic concrete.

Chapter 7 treats of surface finish and chapter 8 of various methods of waterproofing. Chapter 9 covers inspection of concrete sidewalks, curb and pavement construction. Chapter 10 is devoted to concrete products, such as ornamental concrete, building blocks, fenceposts, railroad ties, and sewer pipe. Chapter 11 includes the molding and driving of concrete piles both of the cast-in-place and of the cast and driven types.

Much of the criticism in the review of the former book applies to this volume. The work is virtually a descriptive treatise in the field covered by the chapter captions. Except in the introduction, which bears more particularly upon the nature and scope of concrete inspection and the specific duties of the inspector, the book is general in its scope. To the extent of being a compendium of the detailed information which the inspector should possess for the intelligent prosecution of his duties can it be said to cover the inspection of concrete.

The author remarks in the preface that "where it is possible to say so much, it is not easy to tell where to stop." This fine art in technical writing the author has yet to acquire. There is much repetition and statement of trite or obvious facts which might safely be left to the plain common sense of the reader.

While the book covers no new ground in concrete literature it contains a vast amount of useful reference information upon concrete construction, and will be of interest to all workers in this field. The subject matter is carefully classified by chapters, articles, sections and paragraphs, and the author has succeeded in his aim to present the subject in a form for convenient use and ready reference.

SLIDE-RULE NOTES. By Col. H. C. Dunlop, Late Professor of Gunnery, Ordnance College, Woolwich, and C. S. Jackson. Board cover, 5 x 7½ in.; 127 pages; 58 illustrations. New York, Longmans, Green & Company. 75 cents net.

For the reader who does not possess a knowledge of logarithms the simple graphical demonstration of the mechanics of the slide-rule, given in the first chapter of this small English text, will suggest its easy application to clerical work. Probably the author had this in mind. The book proceeds to show the manner of interpreting functional facts on the sliding scales, dealing with direct proportion, derivation of powers and roots, the use of the trigonometrical and logarithmic scales, and plotting curves from equations. The usual complement of examples is included. Although the work deals almost exclusively with the Mannheim rule, the treatment is so clear that the student should be able to use more elaborate types with little difficulty.

A PRACTICAL TREATISE ON SUBAQUEOUS FOUNDATIONS. By Charles Evan Fowler, Special Lecturer, University of Washington. Cloth, 6 x 9 in.; 814 pages; 477 illustrations. New York, John Wiley & Sons, Inc. $7.50 net.

(Reviewed by E. P. Goodrich, Consulting Engineer, New York.)

C. E. Fowler, consulting engineer and special lecturer at the University of Washington, has written extensively on foundation matters. In 1898 he issued a book entitled "The Cofferdam Process for Piers." In 1904 the book was republished with much additional matter under the title of "Ordinary Foundations, Including the Cofferdam Process for Piers." Now, in 1914, appears an 814-page book entitled "A Treatise on Subaqueous Foundations, Including Ordinary Foundations and the Cofferdam Process for Piers." This new work is profusely illustrated and includes sixty-nine tables and eleven appendices. It is divided into thirty-three chapters, which cover in fair measure practically the whole range of the subject. This fact may be illustrated by several of the chapter headings: "Historical Development," "Crib Cofferdams," "Pile Driving and Sheet Piles," "Jetting Piles," "Metal Construction" (cofferdams, sheet piles, etc.), "Cylinders and Caissons," "Pneumatic Caissons," "Divers and Diving," "Pumping and Dredging," "Drill Scows and Rock Breakers," "Dredges (three chapters), "Tugboats and Scows," "The Foundation" (sub-foundation), "Location and Design of Piers" (bridge piers), "Cement and Concrete," "Piers and Wharves" (two chapters), "Foundations for Locks and Dams," "Forms for Concrete" and "Estimating the Cost" (two chapters). What the author claims in his preface with regard to the chapter on "Divers and Diving"—that "the subject" has been "treated fully enough to make it unnecessary to refer elsewhere for information on this subject"—does not apply to nearly as great an extent to most other parts. A vast amount of information has been collected by the author from his long experience and from the widely distributed literature of the subject. It is with a distinct shock, however, that one notes a reference to a certain well-known engineer as the chief of a large Western trunk line, whereas he has been in practice in the east for at least ten years. Again, while reference is made to very late examples of dredges in quotations from the Engineering Record, no reference is found to a type of machine which is revolutionizing modern ideas of the efficiencies which can be secured with suction dredges, to the Frühling dredges, for example. Perhaps the author will quote in extenuation from the last sentence in the chapter in question, "They can seldom be employed in any way in foundation work."

On the other hand, the author has met in his chapter on tugboats and scows a real need on the part of most engineers who have not had considerable experience as naval architects. As stated in the preface "Practically all foundation work (aqueous) requires the use of launches, tugs and scows, and . . . there is practically no literature on this subject." Had the descriptions and specifications for tugs been as full as are those for a scow the work would have been of still more value.

The reader will be struck with the relatively large amount of special data relating to Pacific Coast conditions, and while the differences between work on the Atlantic or in the interior are not very great, those acquainted with one of these localities will instantly note the variations.

The descriptions of the two actual pneumatic caissons given in any detail for bridge piers are of structures nearly twenty years old, and this fact should be clearly recalled by any one with relatively small experience who reads and makes use of the book.

The chapters on costs contain a miscellaneous lot of information, which, however, can be used only with "fear and trembling," as the author well states at the beginning of the chapter. After commenting on the fact that marked changes have taken place in prices during the last ten years, he inserts most of his data with no date to give a first clue as to how it must be modified to fit other conditions.

Aside from the specifications for cement, the appendixes are of considerable value, as they consist of specifications of work prepared by experienced men for actual structures erected in accordance with them.

As a whole, the book is one for reference for the man without much experience, but it must be followed with caution as must every technical treatise.

WHERE AND WHY PUBLIC OWNERSHIP HAS FAILED. By Yves Guyot, Editor-in-Chief of the "Journal des Economistes." Cloth, 5¼ x 7¾ in.; 459 pages. New York, The Macmillan Company. $1.50 net.

(Reviewed by William J. Cunningham, Assistant Professor of Transportation, Harvard University, Cambridge, Mass.)

The title of the book indicates the author's point of view. Originally written in French, it has been translated into English by H. F. Baker. It is a compilation of notes and quotations relating in detail to practically every phase of National, State and municipal ownership and operation of transportation utilities, telegraphs, telephones and other public utilities, such as water, gas, electricity and dwelling houses. There is also a great deal of material relating to government monopolies in the manufacture of certain articles (such as matches in France) and concerning government monopoly of fire and life insurance.

M. Guyot writes forcefully and cites a wealth of detail and illustration to prove his points. An ardent opponent of nationalization of railways and other public utilities, he makes out a strong case in favor of private ownership with proper control by the government. The treatment is marred somewhat by an evident bias. The government side of the case is not given the full weight which an author more judicially inclined would have accorded it, and the citations and illustrations are taken generally from the writings of authors who are far from temperate in their criticism of all governmental undertakings.

The book is divided into four parts with a total of forty-three chapters. The arrangement is faulty, as there is much overlapping and a lack of balance between parts and chapters. Some chapters contain but one or two pages; others have from twenty-five to thirty-eight pages. There is evidence of haste in writing or lack of revision to insure co-ordination and smoothness. Indeed, the author himself recognizes these defects in the preface, wherein attention is called to the difficulties in making a coherent arrangement of material gathered from so many and incomplete sources. Carelessness is apparent also in some of the statistics. There are obvious errors in some of the tables, such as those on pages 254, 264 and 302.

For his data the author has drawn from the experience of every civilized country in the world, and he has delineated in a striking manner the failure of the government satisfactorily to operate public utilities, particularly the State-owned railways of France, a subject on which M. Guyot is very well informed. The chapter in Part 3 which deals with the attitude of labor under governmental ownership is especially strong. A large part of the author's efforts is directed to convincing his French readers of the folly of continuing or extending the experiments of that country in nationalizing its railways and enlarging its group of government monopolies. A strong warning on the dangers of socialism is sounded and many "horrible examples" are cited.

The author's conclusions are that public monopoly kills the spirit of initiative; that public operation emphasizes the special demands of the communities rather than the fundamental necessities, and provides opportunities for nepotism and corruption; that the effect of governmental employment is to incline employees to exchange their rôle of subordinates for that of masters; that public ownership often penalizes the whole body of taxpayers for the sake of some privileged class, and that the results of public ownership and operation are always less efficient than under private ownership.

Letters to the Editor

Pitometer Test at Sacramento

SIR: I am inclosing the results of a pitometer test as conducted on the pumps of the Sacramento City waterworks. We have one Snow triple, condensing, crank and flywheel pumping engine rated at 10,000,000 gal. per twenty-four hours and one Allis compound, condensing, crank and flywheel type rated at 5,500,000 gal.—both single-acting; also one Holly inclined, non-condensing, crank and flywheel pumping engine rated at 4,500,000 gal. per twenty-four hours, and one Dow tandem compound, non-condensing, duplex type rated at 2,000,000 gal. per twenty-four hours—both double-acting.

RESULTS OF PITOMETER TEST AT SACRAMENTO, CAL.

Name of pump	Rated capacity for 24 hours at speeds noted: Gallons	R.p.m. rated	Gallons	R.p.m. rated	Discharge per 24 hours by pitometer: Gallons	R.p.m. actual	Loss: Gallons	R.p.m. actual	Per cent of slip
Snow .	10,000,000	48	9,496,024	45.8	5,941,405	45.8	3,554,619	45.8	37.40
Allis ..	5,500,000	42	5,484,928	41.9	4,903,839	41.9	581,089	41.9	10.60
Holly .	4,500,000	35	5,135,643	39.94	4,311,733	39.94	823,910	39.94	16.04
Dow ..	2,000,000	45	2,114,712	47.5	1,399,255	47.5	715,457	47.5	33.80

Rated plant output per 24 hours at above-indicated speeds .... 22,231,307 gal.
Actual output .... 16,556,232 gal.
Loss .... 5,675,075 gal.
Combined slip for plant........ 25.52 per cent.

GEORGE R. ROSS,
Chief Engineer of Waterworks Department.
Sacramento, Cal.

Six Hundred Transit Shots in Eight Hours

SIR: I have read with interest your article entitled "Six Hundred Transit Shots in Eight Hours," appearing in the Engineering Record of June 6, 1914.

In 1891, while surveying for the Sanitary District Drainage Canal, I made more than 600 shots in a day time and again, reading both horizontal and vertical angles, as well as distances on stadia rods for each shot. The main line was connected up to triangulation points a mile or two apart.

The survey when platted checked up remarkably well. This survey served as a foundation for all of the Sanitary District work.

JOHN ERICSON,
Chicago. City Engineer.

Cost of Preparing New York City Contracts

SIR: That the cost of preparing contracts under the system at present in vogue in the city of New York is excessive will not be denied by any one who is familiar with it, and for those who are not the following brief description will be found convincing:

1. Specifications are typewritten and, with the exception of a few pages or paragraphs of descriptive matter, are made up from paragraphs and clauses copied bodily from previous specifications for similar work.

2. A contract form is prepared in like manner.

3. The compilation is gone over, corrected, amended, etc.

4. The result of these labors is submitted to the corporation counsel for approval as to legality, etc.

5. The finance department passes on it.

6. The corrected result is sent to the printer.

7. Proof sheets are received and gone over and corrections made.

8. The sheets are returned for final printing.

9. Final printed forms are gone over and if need be corrected further.

10. If no further sanctions have to be obtained, the contract is advertised from four to twelve months after its inception.

Sometimes the bids received are higher than the preliminary estimate and then the whole process has to be repeated. It is only fair to state that for some classes of work an effort has been made to simplify the process, but even in those cases there is room for improvement. To give an idea how the present system works, suppose a certain department erects or gets out contracts for three buildings. This means three contracts of from seventy to eighty pages of printed matter, where perhaps with the exception of about five pages in each the matter is repetition of what has been previously specified.

The following method would eliminate the larger part of the above-cited work and not only reduce engineering costs but tend to standardize the work of the various departments:

1. Adopt standard specifications for all classes of materials used in city work and issue a bound volume that could be obtained by purchase or found on file for reference in the various city departments. This does not mean that one grade of material be prescribed for all work, but that classes or grades be adopted to cover all requirements, as, for instance, Class A concrete might be a 1:2:4 mixture; Class B, a 1:3:5 mixture; Class A brickwork, ordinary rough brickwork, and so on.

2. Adopt standard contract forms for various classes of work, such as for furnishing and delivering materials, for erection of buildings, for general structures, and for hauling and laying water mains. The amount of security, the time allowed and other variables of a like nature would be left blank and filled in on the contract when executed.

3. Proposals would have to be printed and would have to contain in addition to matter now printed a schedule of quantities,

the numbers and pages of the standard specifications that applied to the work to be done, the title of the standard contract that would apply in the matter in hand and the numbers and designation of the plans that formed part of the contract. The following is an example:

"The work to be done consists of furnishing and laying cast-iron water mains on and in the places designated on the following plans: (Plan numbers, etc.)

"The approximate quantities are as follows: (Schedule follows.)

"All work to be done and materials to be furnished are to be as prescribed in the standard specifications of the city of New York in the paragraphs below scheduled: (Paragraphs follow.)

"The above paragraphs are modified as follows: (Give such exceptions, too, with paragraph numbers as may be found necessary.)"

By use of the above-described system the actual new printed matter for each and every contract could be cut down to four or five pages, time could be saved, designers' work simplified and costs materially reduced.

It might seem as if the preparation of the standard specifications would be a difficult matter, but it is simpler than it seems. All city departments have standards for various classes of work, as can be seen by comparing contracts of work that has been done with what is being done at present writing. The standardization would be practically a compilation from specifications now in use, followed by the elimination of repetitions and the fixing of a single standard where the variations were unimportant in quality or cost. A review of the final result by the various department heads would provide against errors and omissions, and the city could have the book printed—sure of the fact that its work would be better done and at less cost. As to the contract forms, co-operation on the part of the department heads, including the legal and financial people, would give forms that probably could be used for years without revision.

The above system involves nothing new or startling and to the writer's certain knowledge was in use on the German Government railroads even prior to 1892.

Rockville Center, N. Y. B. M. Wagner.

Construction Methods in Small Towns

Sir: On the afternoon of June 4 a severe wind and rain storm visited Huron, S. Dak., and vicinity, 3.61 in. of rain falling in a few hours, and demolished a large portion of the concrete foundation wall of a bank building being erected in this city.

The failure of the wall brought to light many circumstances which, though not unusual in buildings in small towns of this size, are interesting as illustrating the necessity for competent supervision of all concrete work and the need of a change in the methods of construction in small towns.

The building as designed is to be a two-story and basement brick structure, 80 x 25 ft., presumably fireproof, faced in front with limestone. All foundation walls are 18 in. thick, of concrete, specified 1 part cement to 6 parts pit-run sand and gravel; and into this concrete were dropped boulders of "niggerheads," a local quartzite, ranging from cobblestones to boulders 18 or 20 in. in diameter. These are specified to be no closer than 2 in. to the sides, and the space between any two stones to be not less than 4 in.—an impossible condition. All foundation walls are about 10 ft. high and had been poured from fifteen to twenty days previously. The forms on the outside of the walls had been removed and loose earth backfill placed.

The construction of the first floor consisted of 15-in. I-beams 7 ft. 6 in. on centers, spanning 25 ft., with reinforced-concrete floor arches. No bearing plates or wall anchors were specified or provided, and the bottoms of the beams were not designed to be protected in any manner.

The floor slabs had all been poured on June 3, the day before the storm, and were not damaged to any extent by the collapse, the centers being still in place.

A portion of the west foundation wall about 25 ft. wide at the top and 40 ft. wide at the bottom failed and fell inward, owing to a 10-ft. head of water directly against it. The ground within a radius of 300 ft. around this wall drained against it, mixing with the loose earthfill to form a fluid, and exerting a tremendous pressure against the wall.

An examination of the work after the accident brought about an inspection of the remaining foundation walls, which revealed that the concrete was of the poorest quality, with practically no strength whatever. Although fifteen or twenty days old, it could be cut into easily with a penknife and picked apart with the fingers.

Investigation disclosed that the concrete was mixed in a machine mixer, a half batch being mixed at a time; half a sack of cement was added to two wheelbarrows of aggregate. The wheelbarrows run from a capacity of 2 to 2½ cu. ft., thus showing that the mix was anywhere from 1:8 to 1:10, instead of 1:6 as specified. And this assumes that the man measuring the cement was genius enough to gage half a sack of cement. All the concrete was poured without any tamping or puddling, the contractor claiming that the boulders being dropped prevented this. The pit run of the aggregate varies very much in the proportion of sand to gravel and no accurate average could be made.

The collapse and resulting investigation led to the following conclusions:

1. The owners were at fault for employing an architect at a commission insufficient to cover the cost of supervision.
2. The architect was at fault for allowing such work to be done, after agreeing to supervise the work.
3. The contractor was at fault in not performing his work as specified.

This letter is submitted to call attention to the methods in vogue in small towns in erecting buildings. The architect with the lowest commission charge is employed and the lowest bidder is awarded the contract without attention to competency, experience or past performances. No supervision is furnished and the contractor is given carte blanche in the prosecution of the work. Although not intending to "skin," his ignorance offsets his good intentions.

No tests of the cement were made, although inspection leads to an opinion that some of the cement used was defective. Three different brands were used and no one knows where which was employed.

Can nothing be done to improve these prevalent incompetent methods?

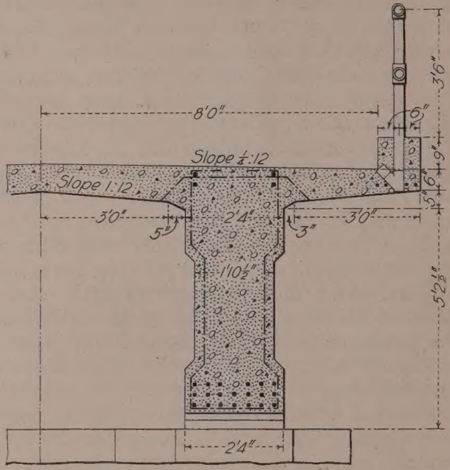
Herbert Cohen,
Superintendent of Construction, U. S. Public Buildings, Huron, S. Dak.

Useful "Kink" in Concrete Bridge Design

Sir: I am enclosing a detail of a reinforced-concrete bridge to be erected across the Gila river near Welton, Ariz. The bridge is 650 ft. long and consists of ten spans, each alternate pier being a "free" pier.

I wish to call attention to the manner of securing the handrail in the curb and of providing drainage for the bridge floor. Each handrail post terminates in a wye-branch instead of the usual flange footing. The wye-branch carries a nipple or other fitting of suitable length to intercept the floor of the bridge at the foot of the curb and drain the roadway through the pipe-rail post.

The pipe rail is designed to be held in place while the concrete is poured by means of cleats notched around the vertical post at the upper surface of the curb and a circular collar of wood tacked to the lagging and surrounding the wye branch at the point where it rests on the forms. When the forms are removed the removal of this collar with the forms leaves a circular dish 1 in. deep in the concrete surrounding the wye. This provides for clean drainage from the bridge floor without any of the discoloring due to the discharge spreading over the under surface of the concrete.

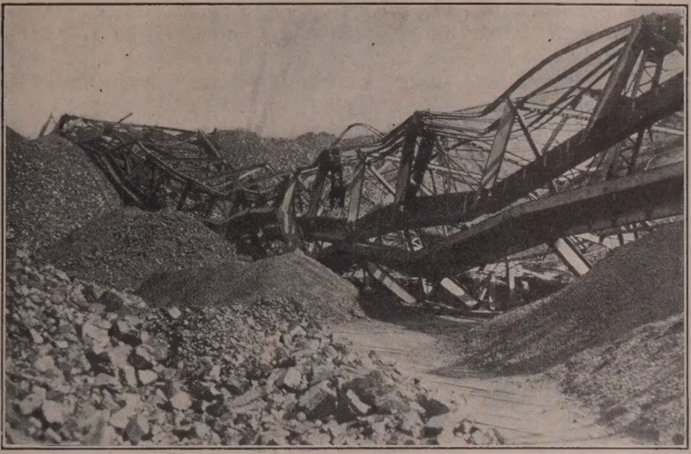


Bridge Detail with Novel Handrail Post

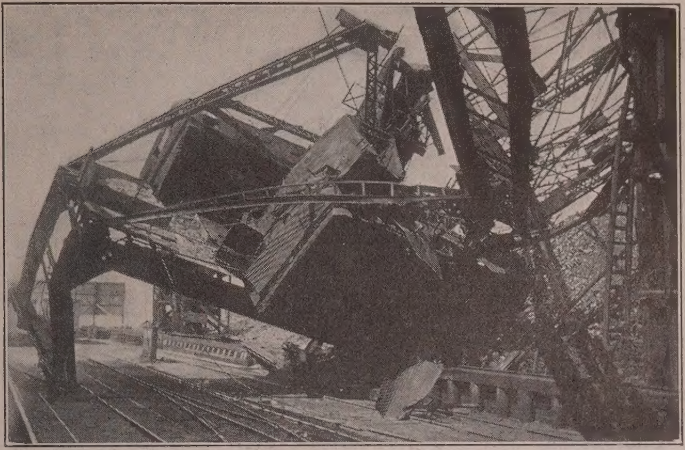
Wherever it is advisable to use pipe handrail this type will be found more convenient to install and hold in place during pouring, as well as cheaper, than that commonly used having flange footings with distinct drain pipes separated from the same.

T. F. Nichols.
Office Engineer, Office of
Arizona State Engineer.
Phoenix, Ariz.

The high cost of railway regulation has been felt by the Pennsylvania Railroad. Compliance with State and Federal regulatory laws has added an estimated sum of $3,200,000 to the annual operating expenses of the system. Of this amount hours-of-service laws have claimed $1,080,000; boiler-inspection laws, $515,000, and "full-crew" laws, $1,180,000. Paying off employees semi-monthly instead of monthly has added $400,000 a year, and maintenance of "Jim Crow" cars costs $43,000 per year. In addition to these annual expenses $5,000,000 has been spent in placing safety appliances on equipment as demanded by law and $603,000 in complying with the requirements for ashpans on locomotives.



1.—Wreckage at One of the Docks on St. Louis Bay



2.—Damage to World's Largest Coal-Handling Bridge

Tornado Wrecks Great Lake Structures

Many Steel Coal-Handling Bridges are Blown Down and Buildings Damaged along Waterfront at Superior and Duluth

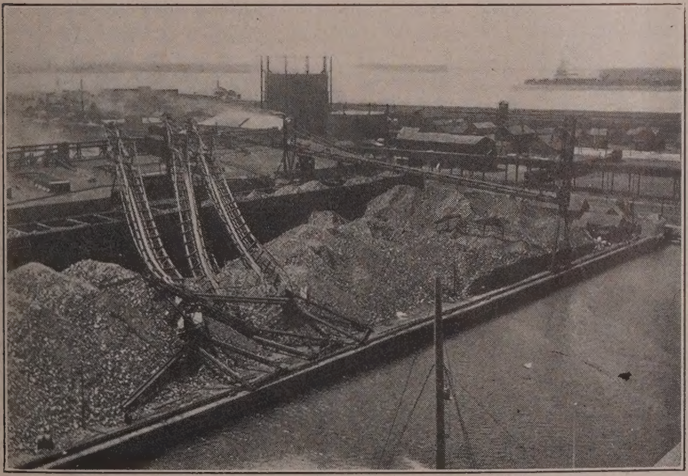
A TORNADO swept over the region at the head of the Great Lakes near Duluth at 5:30 p. m. May 25 and did damage estimated at half a million dollars. Huge coal-handling bridges were wrecked, one of them the largest of its kind in the world. The roof was torn completely off one of Superior's grain elevators. Railroad cars were overturned, dwellings demolished, and one large freight steamer was torn from its moorings, blown a mile and a half across Superior Bay and left stranded on the shore of Minnesota Point.

The wind followed the St. Louis River valley and was from the southwest at the time of the severest blow. The U. S. Weather Bureau reports a maximum velocity of 65 miles per hour, but this cannot be taken as an extreme velocity where the greatest damage was done. The Weather Bureau is located several miles from the docks and perhaps was almost out of the storm path. It is probable that the maximum velocities were much greater than 65 miles per hour.

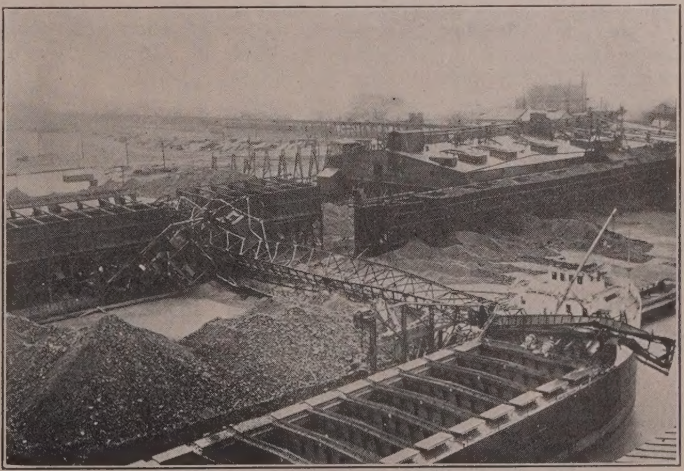
Photograph 1 shows the destruction of the portal pier, operating mechanism, trolley runways and part of the foundation at the Island Creek Coal Company's dock located on St. Louis Bay, Superior, Wis. The bridge is wrecked so completely that none of its parts can be used in reconstruction work. Four sets of clamps and chocks under the wheels failed to hold.

All that is left of the new coal-handling machine at the dock of the Northwestern Fuel Company at Superior Bay, Superior, Wis., is shown in photograph 2. Here the damage was considerably more than $150,000. This electrically operated bridge, which was built only last year, was the largest one in the world. It had a span of 552 ft. and its height from floor to top chords was 140 ft. Twelve-ton buckets were used on this bridge. The Heyl-Patterson Company, builders of the bridge, has been given a contract for a duplicate one to replace it and the company expects to have the bridge ready for operation in three months.

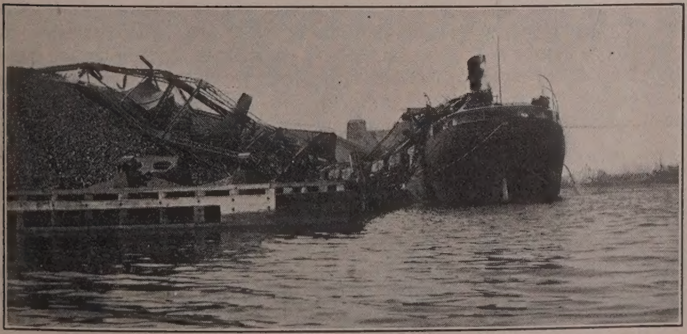
Three rigs of the Clarkson Coal & Dock



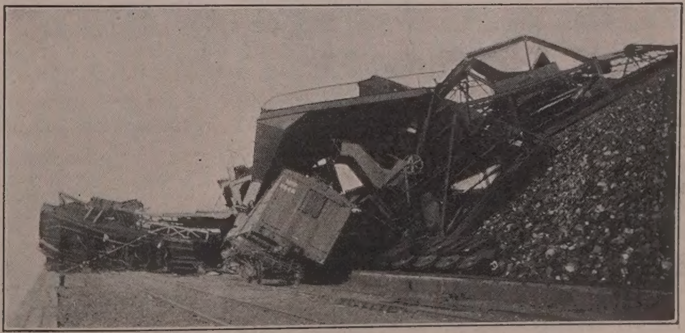
3.—Three Steel Rigs Blown Down at Duluth



4.—Injured Bridge Which Will Be Repaired



5.—Result of Storm at Superior Bay Dock

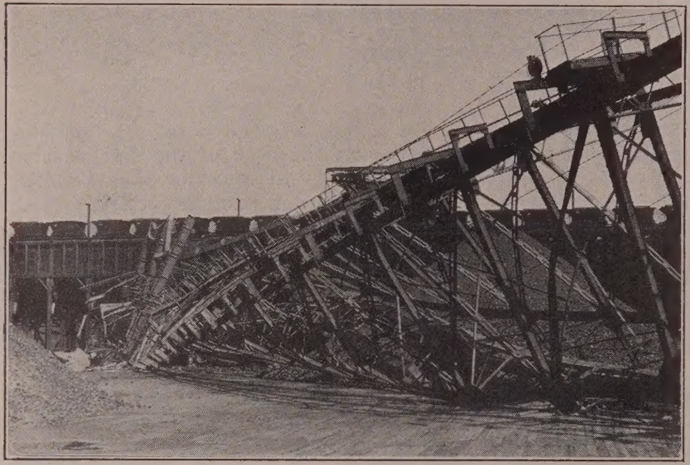


6.—Crumpled Bridge and Car at Superior

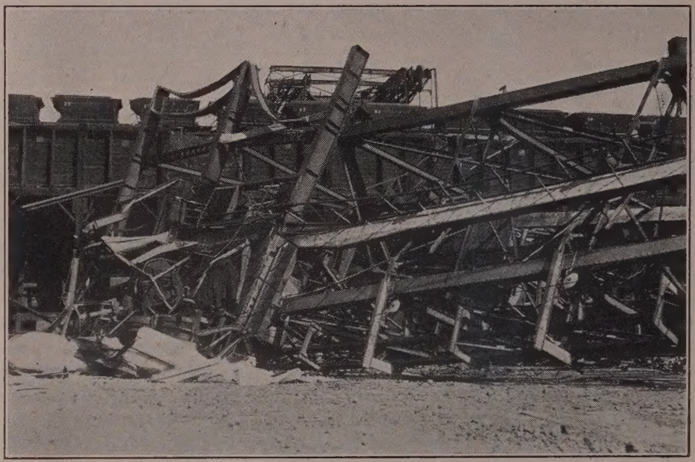
Company at Duluth were blown down as depicted in photographs 3 and 4. These rigs are being lifted and repaired and it is hoped to have them in working order soon.

The steel coal-handling rig in photograph 4 was not blown down in the latest storm but during the gale of April 28. This bridge skidded about 40 ft. before overturning and when it did blow over the apron fell upon the cabin of a steamer, damaging it somewhat but fortunately injuring no one. All the structural steel and machinery has been found worthless and cannot be used in the construction of the duplicate bridge to replace the injured one. The Weather Bureau reports that a gale of 64 miles per hour was blowing from the northwest at the time.

Photographs 5 and 6 give further evidence of the destruction at the Northwestern Fuel Company's docks. Photograph 7 illustrates the torsional manner in which the coal-handling bridge at the Northern Coal & Dock Company's docks in Superior fell. A view of the operating mechanism of the bridge is shown in photograph 8. This equipment is a total loss; neither the structural steel nor the machinery can be used in rebuilding.



7.—Manner in Which Steel Bridge Was Blown Down



8.—Close View of Bridge Operating Mechanism

So great was the velocity of the wind that the roof of one of the elevators of the Great Northern Railway Company's system at Superior was torn off. A portion of this roof was carried high into the air and over another elevator several thousand feet away.

Operating Results at Minneapolis Filtration Plant

Yearly Report Points out Unusually High Color Content, Need for Educating Public in Filtration and Softening Possibilities

ANTAGONISM against the filtered-water supply of Minneapolis, engendered by spring water companies, reached such proportions that F. W. Cappelen, city engineer, has recommended the construction of a municipal street-car line, $1\frac{1}{4}$ miles long, to connect with the traction company's line and thus enable citizens to visit the plant and learn at first hand what is being done there for their benefit.

Filtered water was turned into the city mains Jan. 10, 1913, and the results of practically the whole year are given in Mr. Cappelen's report, from which these notes are taken. The plant comprises a 75,000,000-gal. settling basin and twelve rapid filters, each of 3,250,000-gal, daily capacity, described in the Engineering Record of Nov. 18, 1911, page 586. Defects noted with reference to wash water inlets to the filters, concrete ridge blocks and the strainer plates have involved a gradual reconstruction at an expense of nearly $11,000. The original coagulation basins were found to be too small and an additional one is practically completed. Four additional filters are under way and will probably be ready for service by Aug. 1, so that the plant can produce normally 52,000,000 gal. daily and 64,000,000 gal. as a maximum.

For the year the lowest monthly cost per 1,000,000 gal. was $3.66 and the highest $11.53, the average being $9.18, of which alum cost $4.65; bleach, 36 cents; labor, $2.53; wash water, 60 cents, and miscellaneous, $1.04. Application of alum varied from 0.68 grain per gallon in January, when the water had a color of 14, to 5.62 grains in July, when the color was 70. The average color content was 44 in the raw water and 16 in the effluent. Alum costs 94 cents per 100 lb., bleach $1.58 per 100 lb. and wash water 2 cents per 1000 gal.

BACTERIAL REMOVAL

Bacterially the river-water content is 1065 on agar at 37 deg. C for the highest monthly average, while the effluent never was above 17 for a like period. The settling basin high and low counts were 560 and 40. Gelatine counts were made during five months only, the effluents all showing less than 25 per cubic centimeter.

B. Coli were present in a great portion of the 10-cu. cm. samples of both river and settling basin. In the filtered water no colon bacillus was found in 10-cu. cm. portions during eight months of the year. Following the tuning-up period in January and February, 20 and 13 per cent of the tests were positive. Again in April and in August 3 per cent of the 10-cu. cm. samples were positive. All other months were 100 per cent negative. In the city tap 100 per cent of the 1-cu. cm. samples were negative, while in the 10-cu. cm. portions from 3 to 14 per cent showed positive, except for four months with 100 per cent negative results.

SOFTENING EXPERIMENTS

Softening experiments made by L. I. Birdsall, superintendent of filtration, indicate the best results were obtained when adding 4 grains of lime, as milk of lime, and allowing the reaction to proceed for one hour, then adding 2 grains of alum and permitting the reaction to proceed for two hours more. The data show a reduction in the color from 39 to 11, alkalinity from 145 to 49, and total hardness from 155 to 69. The permanent hardness is increased by the treatment from 10 parts per million in the raw water to 20 parts in the filtered water. No after-reactions were noticeable in the filtered water after it had stood for a period of twenty-two hours, which would indicate that there would be no trouble from aggregates of lime on the sand grains of the filters.

The floc formed by the chemical reactions is voluminous, and much better for purposes of purification than is the floc formed by alum alone. The floc settled readily in less than three hours and left a comparatively clear supernatant water. When using alum alone the floc forms very slowly and is not voluminous as it should be. It is Mr. Birdsall's opinion that the high color in the river water accompanied, as it is, by a large amount of dissolved vegetable matter, retards the action of the alum, especially as there is naturally in the river water only a small amount of turbidity or suspended matter, the presence of which is always an aid in the formation of a good floc. When alum is added to the water already treated with lime the artificial turbidity produced is a great aid in forming a good floc. The lime in combining with the vegetable matter, or organic acids in the water, also permits the alum to react more quickly. When more than 5 grains of lime were used the water was over-treated and contained caustic lime in solution. The color of the raw water in this case was low, but in other experiments in which the color was high the lime alone was insufficient to reduce the color as desired and seemed moreover to set the remaining color so that it was more difficult of removal by the alum added afterward.

The use of lime in softening the city water does not increase the permanent hardness above that obtained when treating the water with alum alone, but, on the contrary, the data show that the increase in the permanent hardness is less when lime is used with alum than it is when alum is used, and the total reduction of the hardness of the water will be safely 50 per cent. The data also show that there will be a slight increase in cost of the treatment, but this is trifling compared with the great saving in soap to the community at large.

PRACTICALLY ALL of the ties used on the 8000 miles of railways in New York State came from other States, according to a bulletin of the State School of Forestry.